

Water

38

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Contents

SOME OF THE THINGS WATER CAN DO	4
WATER FOR LIVING THINGS	10
Water Is Needed for Some Chemical Reactions	11
Water Is a Structural Material	12
Water Is a Carrier	15
Water and the Cooling System	16
Water Is a Lubricant	16
Why Do We Need Water Daily?	17
How Much Water Do You Use Daily?	18
THE WATERS OF THE EARTH	19
A Water Cycle	20
Does the Air Contain Water You Don't See?	22
Does the Soil Contain Water?	23
What Happens to Water That Falls to the Ground? ..	23
The Great Water Cycle	24
Why Is the Sea Salty?	25
AUSTRALIA, THE DRIEST CONTINENT	26
TEST YOURSELF	28
ABOUT THE OPTIONS	31
OPTION 1: UNDERGROUND WATER	32
OPTION 2: WATER IN THE AIR	40
OPTION 3: NATURE'S THERMOSTAT	44
OPTION 4: SOLID WATER	51
OPTION 5: PLANTS GIVE OFF WATER	56
OPTION 6: HARD WATER	59
OPTION 7: SURVIVAL ON LAND OR WATER	65
OPTION 8: POLLUTION IN WATER	68
CHECK YOUR ANSWERS—QUESTIONS	78
TEST YOURSELF	80

In the first section, you learn how water behaves, and its importance to living things, particularly humans. You find out about the way water moves, and some of the things it does while it is moving. You also become familiar with water supplies in Australia.

After you have found out about these things, and completed Test Yourself, you can choose from the options.

When you see the symbol  there will be something to do in your other book, the record book.



The Earth would be quite a different place without water.

There would be no seas, no ice caps, no rivers, no lakes.

The land surface would be different too, because water has shaped and altered almost all of the exposed surface.

There would be no life on the Earth without water.

Man needs water. He needs water for his own body; for growing his crops; and for his animals.

He has used water to give power to some of his machines; for boat transport; for the enjoyment of swimming and water games; and for making his surroundings attractive.

This is why civilizations have developed close to plentiful fresh water supplies.

Compared with most other countries, Australia has only a very small supply of fresh water. So we need to use our fresh water carefully. We also need to make sure our supplies are not destroyed by pollution.



*Water skiing on
Mt Isa storage lake.
(By courtesy of Mt Isa Mines Ltd.)*

SOME OF THE THINGS WATER CAN DO

Water behaves in different ways with different substances.

Some substances change to different substances when added to water. That is, they chemically react with water.



WARNING: Sometimes chemical reactions are violent, even explosive. So when you mix any chemicals for the first time, make sure you watch the reaction at arm's length and take particular care of your eyes.

Another safety precaution is to mix only very small amounts of the chemicals, and watch the reaction through the sides of the vessel. Do not peer over the open top.

WATER AND SOLID SUBSTANCES

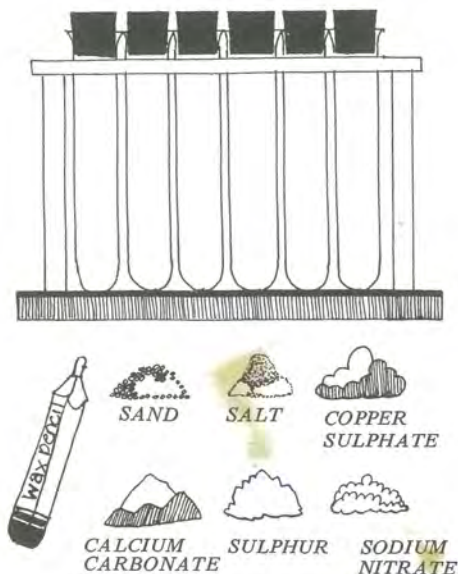
In this activity the substances you use should not react chemically with water. However, you will see that they do not all behave in the same way.

You will need:

- 1 marking pen
- 6 test-tubes with stoppers
- 1 test-tube rack.

- 1 Wash the test-tubes, dry their outsides, and place them in the rack.
- 2 Use the pen to number the test-tubes 1 to 6.

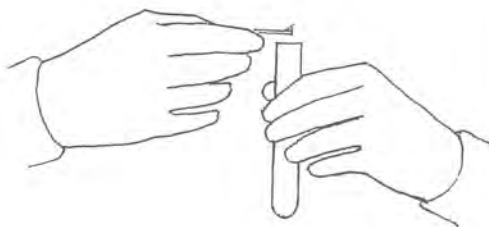
- 3 The substances you will be using are sand, sodium nitrate, sulphur, copper sulphate, table salt, and powdered calcium carbonate. Take the test-tubes to where these substances are arranged.



4 Add a very small amount of sand (about as much as you scoop out on the end of a match) to test-tube 1.

5 Use another match and in the same way add a very small amount of the next solid—sodium nitrate—to the next test-tube.

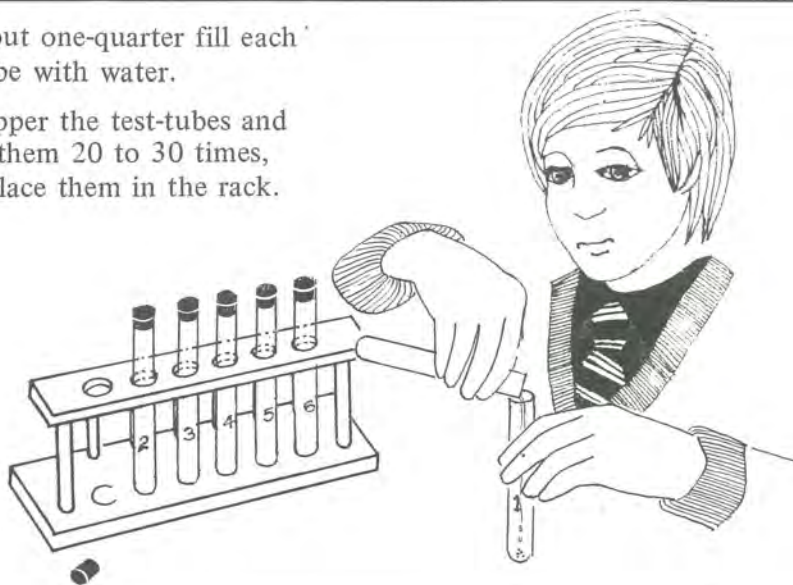
6 Add a different solid to each tube. Take care that you add sulphur to test-tube 3, copper sulphate to test-tube 4 and so on, so that you know which material each tube contains.



Return to your bench.

7 About one-quarter fill each test-tube with water.

8 Stopper the test-tubes and shake them 20 to 30 times, then place them in the rack.



You are now ready to start filling in the first three columns of Table 1 on page 3 of your record book.

9 Examine the contents of the first test-tube to see if any of the solid has sunk to the bottom. If it has, shake the tube another 20 times and then look to see what happens.



1 Put a tick in the appropriate column of Table 1 opposite the name of the substance. For example, if sand is at the bottom of the tube put a tick in the first column opposite 'sand'.

Note: For some substances it may be necessary to put a tick in more than one square.

10 Repeat step 9 and  1 for the five remaining substances.

Before filling in the last column, read further to find out how you can tell if a substance has dissolved (disappeared).

From the rack take the test-tube containing water and calcium carbonate (test-tube 6) and the one containing table salt and water (test-tube 5). Hold these two side by side and examine them.

For each test-tube you should notice whether:

- ☐ You can see your fingers through the test-tube and its contents.
- ☐ Pieces of the solid can be seen.
- ☐ Pieces of the solid slowly settle to the bottom.
- ☐ The liquid looks the same at the top of the container as it does at the bottom.



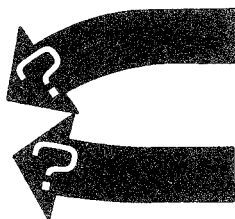
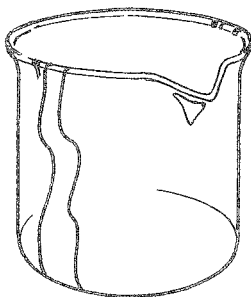
You probably noticed that calcium carbonate and salt behaved in different ways when mixed with water. One of them dissolves and the other one doesn't.

Look at the one which dissolved and see if you agree with these three observations.

A solid substance is said to dissolve in water if:

- Pieces of solid disappear.
- The liquid looks the same at the top and at the bottom of the container.
- The solid does not start to fall to the bottom again after a few minutes.

 Learn these three ways of telling if a solid dissolves, then test yourself by filling in the last column of Table 1.



WHAT DOES 'SOLUBLE' MEAN?

If a substance dissolves it is called a **soluble** substance.

If it does not dissolve it is called **insoluble**.

 2 On page 3 of your record book, make a list of three soluble substances and three insoluble substances from the ones you have tested.

WHAT IS A SOLUTION?

When one substance dissolves in another, the two substances together are called a solution.

WHAT IS A SUSPENSION?

If the particles (the small bits of solid material) stay scattered throughout the water, the mixture is called a **suspension**. Usually a suspension is not clear and the particles begin to fall to the bottom if the mixture is left to stand.

 3 Which of the solids you tested formed a suspension? Write your answer on page 3 of your record book.

DO LIQUIDS DISSOLVE?

You know that some solids are soluble in water, but what about liquids? Do some dissolve in water?

To find out, you will need:

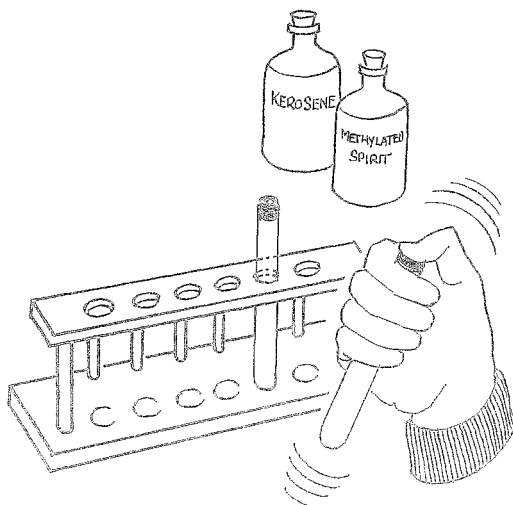
- 2 test-tubes and rack
- 1 ml of kerosene
- 1 ml of methylated spirit.

1 Half fill the first test-tube with water and place it in the rack.

2 Add 1 millilitre of kerosene to the water and shake it well.

3 Half fill the other test-tube with water.

4 Add 1 millilitre of methylated spirit to it. Shake it well.



Let both tubes stand in the rack for about 30 seconds, then examine each test-tube.

 4 What differences do you notice about the substances in each test-tube? Write your answer on page 3 of your record book.

Think of some of the liquids you have mixed at home. Try to remember

whether they dissolved or not. For example: oil and water, cordial extract and water, milk and water.

 5 On page 4 of your record book, write the names of some liquids that dissolve in water and some that don't. (You might like to try some of them at home before you fill in this section.)

DO GASES DISSOLVE?

Why is there a 'pop' when you remove the top of a soft-drink bottle?

What causes the bubbles?

Do you think some gases have been dissolved in the soft drink?

Animals and plants often live in water. They use gases and they produce them. So there are probably some gases dissolved in ordinary water.

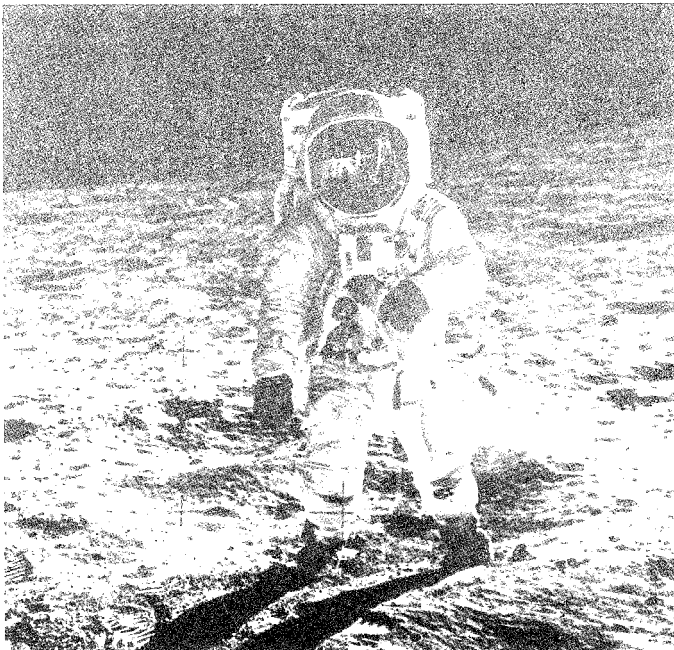
You can see bubbles in a soft drink when you reduce the pressure by opening the bottle. Could you see bubbles in water if you reduced the pressure?

You could discuss answers to these questions with other students.

In a library, try to find out why astronauts wear pressure suits.



A glass of lemonade.



(Photo by courtesy of National Aeronautic and Space Administration.)

WATER FOR LIVING THINGS

I JUST CAN'T
IMAGINE MYSELF
BEING ALL THAT WATER



The bodies of most animals and plants contain a great deal of water.

Below is a bar graph showing how much of the mass of some animals and plants is made up of water.



6 About what percentage of man's mass is water?

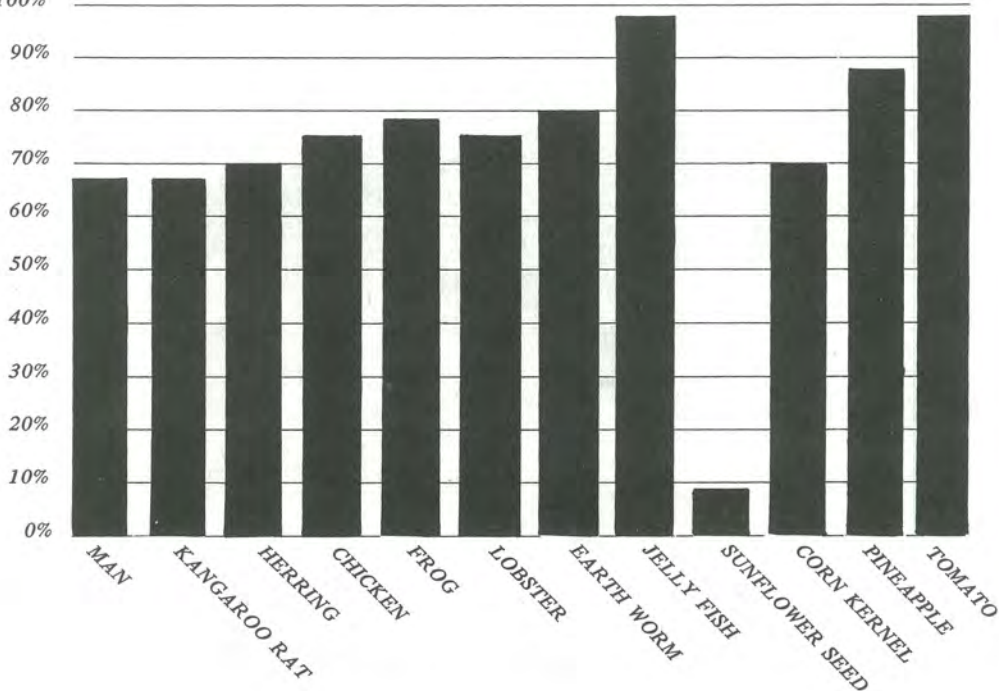


7 If you ate 100 grams of pineapple, how much water would you be eating?

The bar graph shows that well over half the mass of nearly all the animals and plants listed is made up of water.

Do you know why living things need water? There are a number of reasons.

WATER
100%



WATER IS NEEDED FOR SOME CHEMICAL REACTIONS

Nearly all chemical reactions that take place inside living things do so in a water solution.

Here is a chemical reaction you can try. For this activity use only small amounts of the chemicals, about as much as will fit easily on the curved end of the wooden spatula.

You will need:

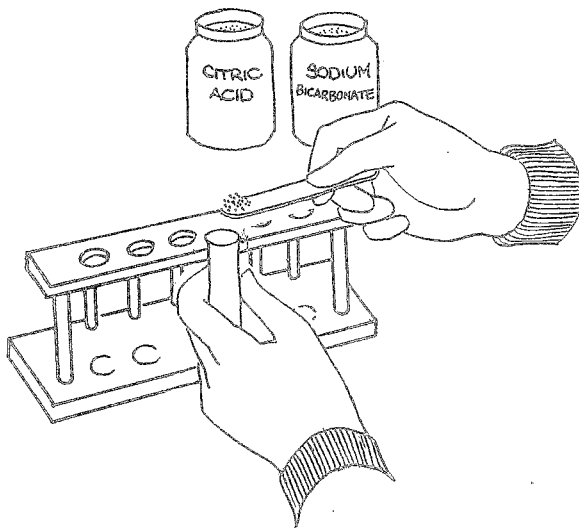
- 3 dry test-tubes and rack
- 1 wooden spatula
- a small amount of citric acid
- a small amount of sodium bicarbonate.

Put a small amount of the citric acid into the first test-tube.

Add two drops of water and observe.



8 For this activity record your observations in the appropriate rectangle in the last column of Table 2 on page 4 of your record book.



Put a small amount of the sodium bicarbonate into the second test-tube.

Add two drops of water and observe.



9 Record your observations.

Put a small amount of the citric acid into the third test-tube.

Now add the same amount of the sodium bicarbonate to the same test-tube. Shake to mix, and observe.



10 Record your observations.

Now add two or three drops of water to the third test-tube and observe.



11 Record your observations.

Now you can wash the test-tubes and leave them to dry.

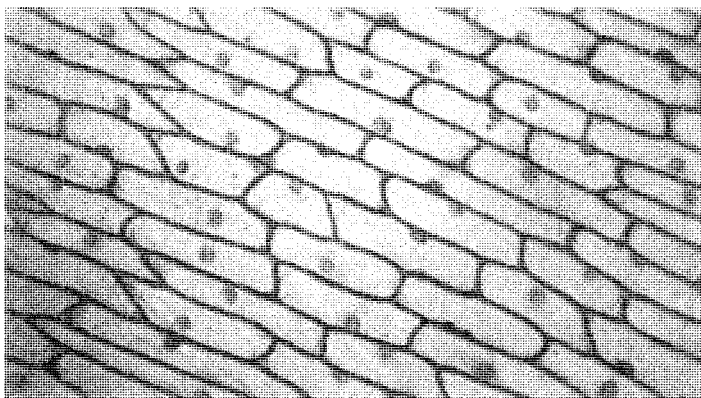
Many but not all chemical reactions are like the ones you have just seen. Many reactions will only take place when water is present. This is particularly true of reactions taking place in living things.

WATER IS A STRUCTURAL MATERIAL

The bodies of all living things except viruses are made of cells.



Cells from the inside lining of a human cheek.



Cells of an onion.

Water keeps the cells blown up. Without water the cells collapse like empty balloons. This is why a plant wilts when it is deprived of water.

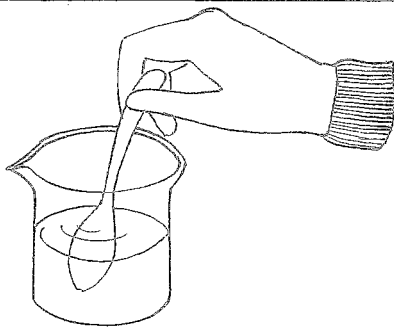
The process by which cells take in water is called osmosis (*oz-MOSE-is*).

You can see osmosis at work in this activity.

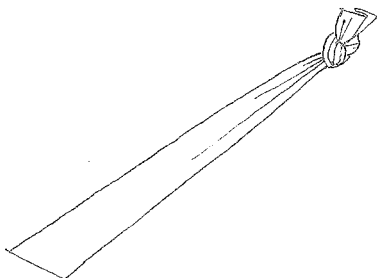
You will need:

- ⊗ 1 beaker, 250 ml
- ⊗ 4 teaspoons of sugar
- ⊗ 20 cm of dialysis (*DIE-al-i-sis*) tubing
- ⊗ 1 funnel.

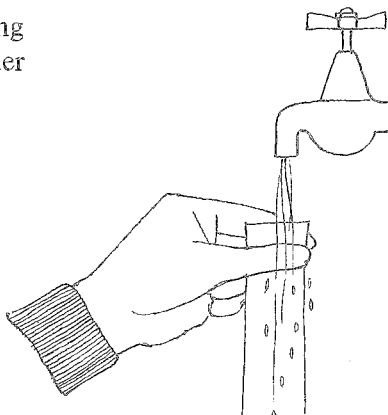
1 Half fill the beaker with water and dissolve the sugar in the water.



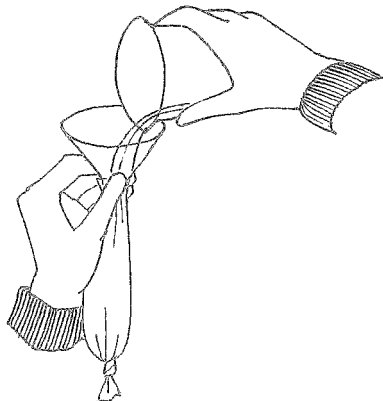
2 Examine the dialysis tubing. It looks like a strip of plastic, but it is really a flattened tube made of a membrane (a thin pliable sheet). Don't try to open the tubing yet, but tie a knot in one end of it. The knot must be tied tightly so that it forms a water-tight seal at one end of the tube.



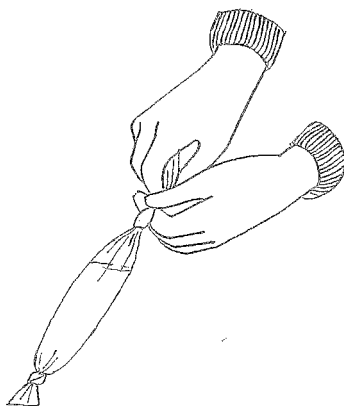
3 Open the dialysis tubing by holding the end which has not been tied under a stream of tap water. Then rub the open end between your fingers.



4 Three-quarters fill the dialysis tube with the sugar solution. Then loosely tie a knot in the open end of the tube.

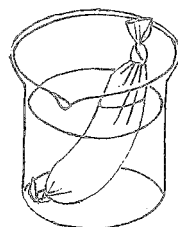


5 Work the knot down the tube until it is just above the surface of the solution. Then tie it tightly to make a water-proof seal.



Notice that the solution does not fill the tube. Also, the tube is sagging.

6 Wash the beaker and three-quarters fill it with fresh water. Then place the tube in the beaker of water and leave it overnight.



WATER IS A CARRIER

7 Examine the tube next day or during the next period. Because you can't answer questions 12 and 13 now, go on to the next section, Water Is a Carrier.

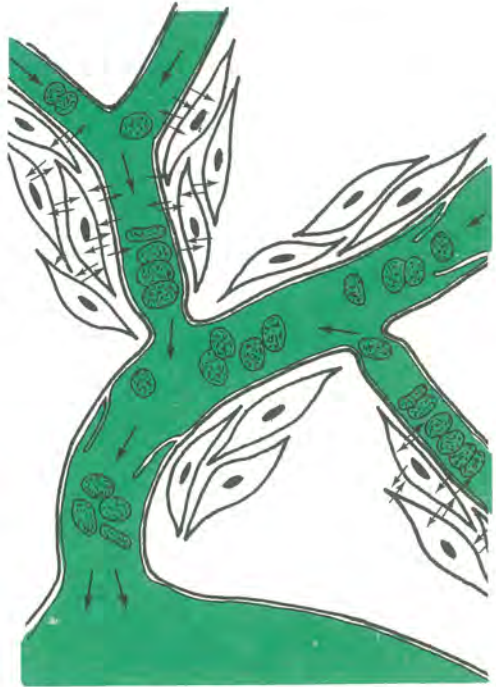
 12 What do you notice about the dialysis tubing? Write your answer on page 4 of your record book.

 13 Try to write an explanation for what you have observed. Then check your answer with the one on page 79 of this book.

The outer membranes of the cells of living things act in much the same way as the dialysis tube. That is, they are **semi-permeable membranes**.* This is why a wilted plant revives when placed in water. Its cells become swollen with water so the plant becomes stiffer.

As an extra activity you might like to find what would happen to the swollen dialysis tube if it were placed in a sugar solution made by dissolving eight teaspoons of sugar in a beaker half-filled with water.

Watery solutions carry materials throughout the bodies of larger animals. Human blood is made up of about 83 per cent water. The blood carries digested food and oxygen to all cells of the body. Waste materials such as carbon dioxide and urea (*yoo-ree-a*) from the cells are passed into the blood stream. The blood transports these materials for removal to the lungs and kidneys.



Blood carries food and oxygen to cells and waste materials from cells.

* See answer to question 13 on page 79.

WATER AND THE COOLING SYSTEM

When any liquid evaporates, heat is transferred from the immediate surroundings, which then become cooler.

Collect a little methylated spirit and rub it on the back of your hand.



14 On page 5 of your record book, describe everything you noticed.

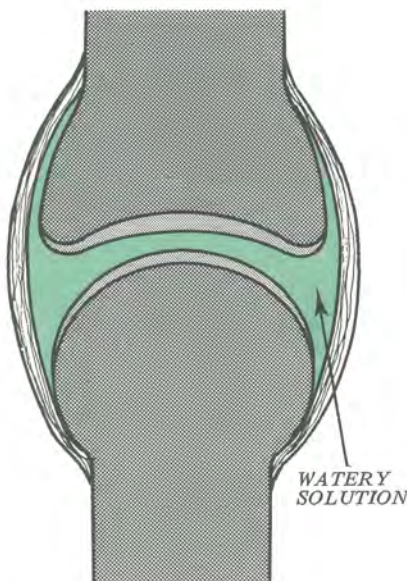
Sweat is 99 per cent water. When it evaporates from the body's surface, the surface becomes cool. You could read more about this in the section on latent heat in Option 3 (Nature's Thermostat).

WATER IS A LUBRICANT

In the body, water solutions lubricate the joints so that they don't squeak, and lubricate soft tissues so that they don't stick together.



Perspiration helps to cool us.



Joints are lubricated by watery solutions.

WHY DO WE NEED WATER DAILY?

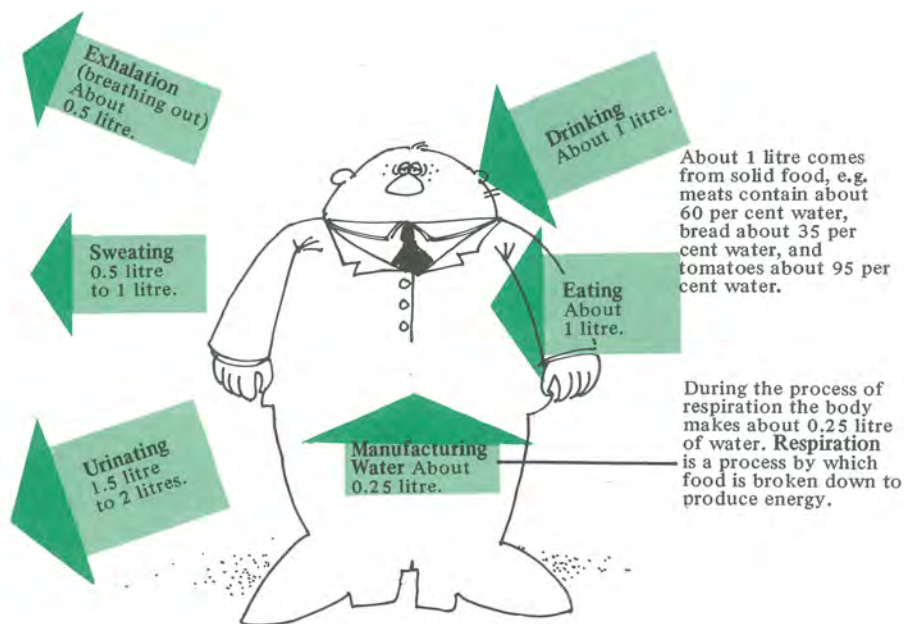
In the human body most water is reused many times. But each day man loses about 2.5 litres to 3 litres of water.

This water is lost in various ways.

To remain alive, man must balance this loss of water.

WATER LOST

WATER GAINED



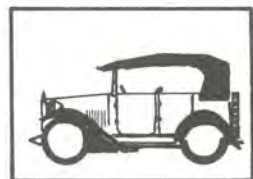
HOW MUCH WATER DO YOU USE DAILY?



+



+



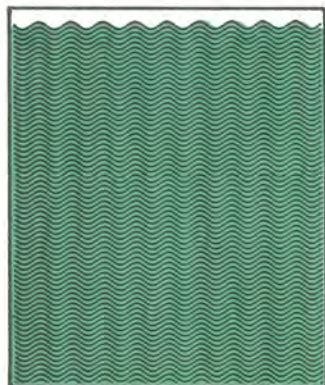
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etc.

=



To remain alive, the body needs only 2.5 litres to 3 litres of water daily.

How much water do you think you use every day for this and other things?

Try to keep a record of how much water your family uses each day. You can use the space on page 5 of your record book. To make an accurate record, you could measure all the water used for a week and divide this amount by seven. You could count the washing of clothes and car only once a week. Then divide by the number of people to find the average amount each one uses.

You may find it difficult to calculate the amount of water used for some other purposes. Here are some hints.

- A lavatory in most homes uses about 4.5 litres of water each time it is flushed.
- To find how much water is used during a shower, you could collect the shower water by plugging the outlet hole. You could then bail the collected water and measure it.
- For gardening, you could collect in buckets the water coming out of the hose in one minute. Then if you hosed for ten minutes the amount of water used would be ten times this amount. If you hosed for 20 minutes, the amount of water would be 20 times the amount for one minute, and so on.



15 What is the average amount of water used each day by one person at your home? Write your answer on page 5 of your record book.

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THE WATERS OF THE EARTH

Water covers nearly three-quarters of the Earth's surface.* The total amount of water is about 1 400 million cubic kilometres. Nearly all, about 97 per cent, is salt water. The remaining 3 per cent is fresh water.

About 97 per cent of the fresh water is frozen in the polar ice caps, and almost all the rest is underground water—water below the Earth's surface. You could read more about this in Option 1 (Underground Water). Only a small amount of fresh water, less than 1 per cent, is at the surface or in the air.

Nearly all the surface water is in lakes. But about 15 000 cubic kilometres of fresh water moves (circulates). It circulates through the air; falls as rain or snow; seeps beneath the Earth's



ON SURFACE
OR IN AIR



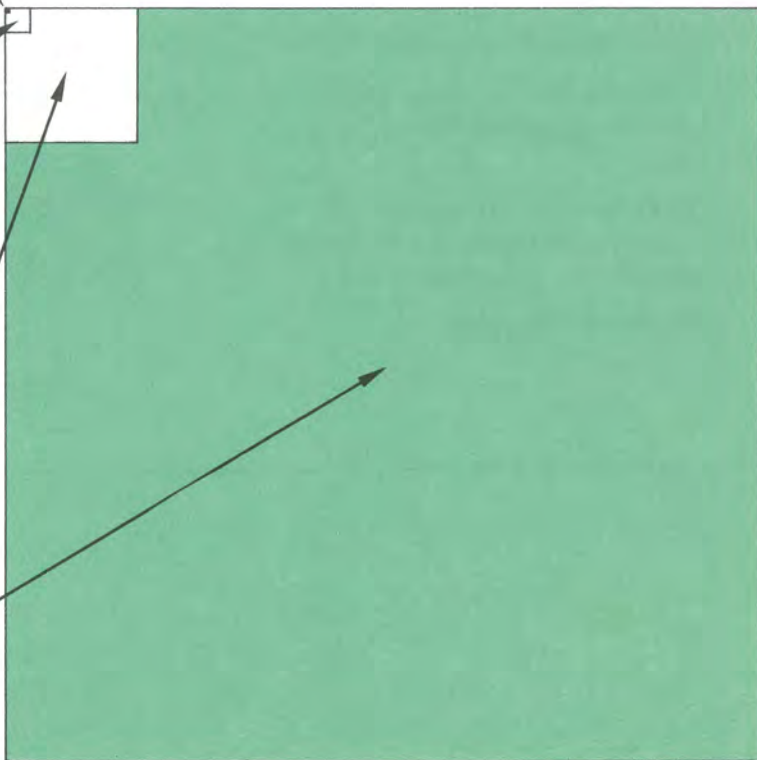
UNDERGROUND
WATER



POLAR ICE



SALT WATER



* The exact amounts of water in its different states are not known. However, the figures given may be a useful guide.

surface; travels through rivers or lakes; and eventually returns to the sea.

From every part of this path, evaporation returns some water to the atmosphere. Here it is carried by winds, until once again it falls as rain or snow or hail.

This great cycle of evaporation and precipitation (*pre-SIP-i-tay-shn*) is called the **water cycle**. The removal of water from the air as rain, hail snow or frost is called **precipitation**.

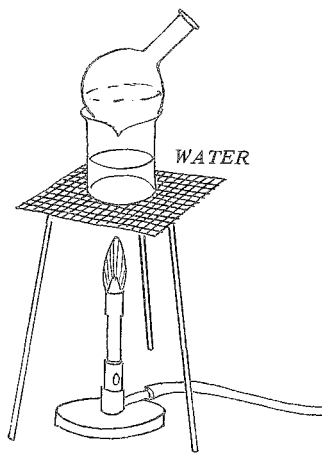
A WATER CYCLE

In this activity, you can set up a small water cycle.

You will need:

- 1 beaker, 100 ml
- 1 round-based flask
- 1 stand
- 1 heater
- 1 gauze mat.

- 1 Pour water into the beaker to a depth of about 1 centimetre.
- 2 Place the beaker on the gauze mat on top of the stand. Then heat the water.
- 3 While the water is heating, about one-quarter fill the flask with water. Then rest it on top of the beaker.
- 4 Watch what happens.





16 What forms on the bottom of the flask and where did it come from? Write your answer on page 6 of your record book.



17 What happens to the material that forms on the bottom of the flask?

You have been looking at a water cycle.

Water does not have to be heated by a burner for evaporation to take place. The Sun's warmth will evaporate water. Also, it was not necessary to use water in the flask to condense the

water vapour. (Condense means to change from gas to liquid.) The burner and the water in the flask only hastened the process.

Have you ever noticed how, after a spring shower, small clouds of water rise from a wet road on which the Sun is shining? Water which came from the air in the form of rain is being returned to the air by the Sun's heat.

The photo below shows it is possible to see water being returned to the air. But does the air contain water we don't see? You can find out in the next activity.



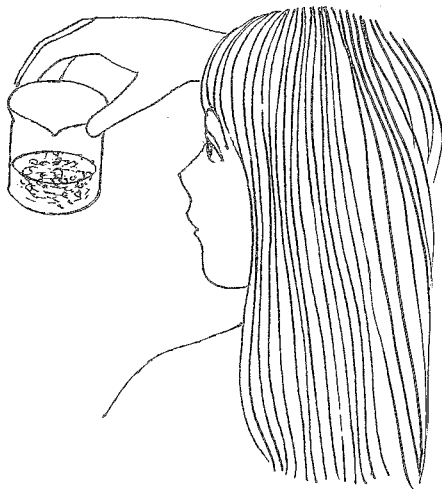
Small clouds of water rising from a wet road.

**DOES THE AIR CONTAIN
WATER YOU DON'T SEE?**

To answer this question, you will need:

- ⊕ 1 beaker, 100 ml
- ⊕ 2 heaped teaspoons of crushed ice
- ⊕ 1 teaspoon of table salt
- ⊕ paper towelling—to dry beaker.

- 1 Carefully dry the outside of the beaker.
- 2 Put the ice and salt in the beaker. Hold the beaker near its rim and stir the ice and salt together.
- 3 For a few minutes look at the sides of the beaker.



Where does this water go?

-  18 What forms on the outside of the beaker? Write your answer on page 6 of your record book.
-  19 Where has this material come from?

Water vapour is in the air all the time, but special conditions are needed to change the vapour to water or to frost. One way is to lower the temperature.

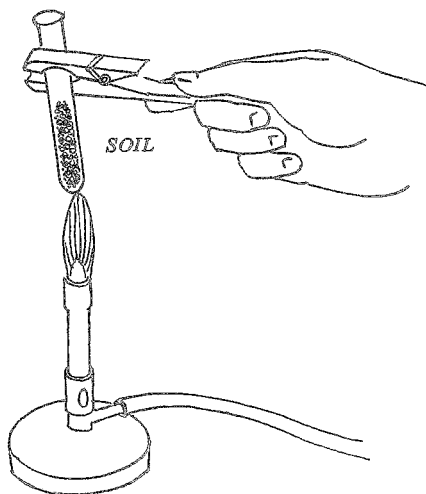
The amount of vapour in the air varies from time to time. You can find out more about this in Option 2 (Water in the Air).

DOES THE SOIL CONTAIN WATER?

You will need:

- 1 test-tube
- 1 burner
- 1 test-tube holder
- 1 pair of tweezers.

- 1 Go outside and half fill the test-tube with soil that looks dry.
- 2 Use the tweezers to remove any sticks or pieces of leaves.
- 3 Light the burner and use it to heat the soil in the test-tube. Hold the test-tube so that the burner flame is near the base of the test-tube.
- 4 Look through the glass at the inside walls of the test-tube.



20 What did you notice? Write your answer on page 6 of your record book.

If you let the test-tube cool, and allowed the water drops to run back into the soil, you would have completed another water cycle.

There is some water in almost all soil. In Option 7 (Survival on Land or Water), you can read about a desert survival kit that enables you to obtain water from desert soil.

WHAT HAPPENS TO WATER THAT FALLS TO THE GROUND?

Most of the water that comes from the air as rain, doesn't return to the air as quickly as water which rises as a cloud from a road after a spring shower. More often the water soaks into the ground. Then it travels a long way through the ground before it is once again returned to the atmosphere. This is discussed in Option 1 (Underground Water).

THE GREAT WATER CYCLE

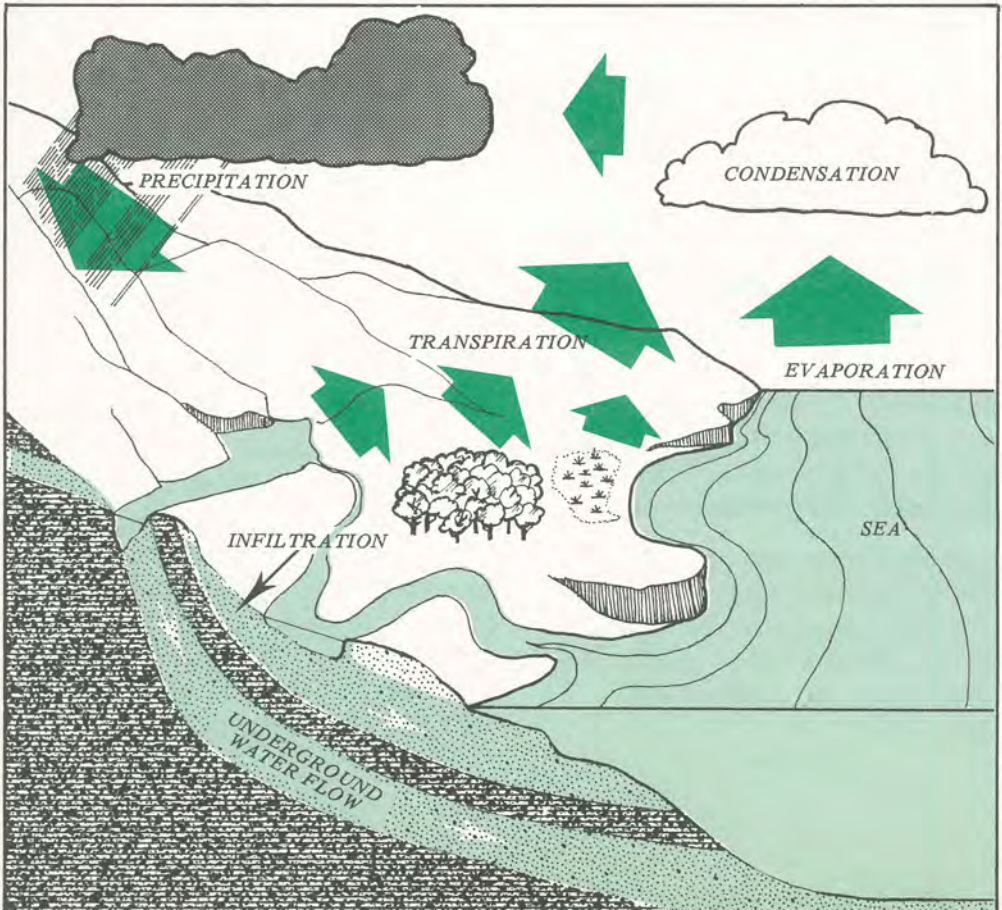
Nature performs the water cycle on a grand scale. Much water is evaporated from the surfaces of sea and land.

Much water is also transferred from below ground to the air by plants. This process is called **transpiration**. You can find out more about this on page 58 in Option 5 (Plants Give Off Water).

Animals also return to the air some of the water they take in. For example,

you have probably noticed that when you breathe on a mirror, the mirror becomes foggy with water from your breath.

Moisture-laden air is carried by winds to colder regions, where water vapour condenses. (You saw this when you did the activity with crushed ice and salt.) Depending on conditions, the moisture may be removed from the air as rain, hail, snow, frost or dew.



WHY IS THE SEA SALTY?

One effect of the water cycle is to make the sea salty.

The rivers that flow to the sea seem to contain fresh water. The rain that falls into the sea is fresh water. Why then is the sea salty?

This activity will help you find out.

You will need:

- 1 sample of sea water
- 1 evaporating basin
- 1 stand
- 1 gauze mat
- 1 burner.

- 1 Thoroughly wash the evaporating basin.
- 2 Pour the sea water into the evaporating basin to a depth of about 1 centimetre.
- 3 Place the evaporating basin on the gauze mat on top of the stand.
- 4 Light the burner and heat the water.

WARNING: When the water boils, hot material from the basin may spit into the air. To lessen this danger the water should be boiled gently.



- 5 Keep the water boiling gently until all of it evaporates. Remove the burner while the last of the water is evaporating, or the heat will crack the basin.



21 What do you notice in the evaporating basin? Write your answer on page 6 of your record book.

One of the most widely distributed materials in the world is common salt—sodium chloride. It dissolves in water. As the water moves over and through land during its passage to the sea, salt

and other materials dissolve in the water. When the water evaporates these materials remain.

Each supply of water moving to the sea brings more salt to the sea. As the water evaporates, the salt is left. As this process is going on all the time, the sea is becoming more and more salty.

You can check your answers on page 79 of this book.

AUSTRALIA, THE DRIEST CONTINENT

You have just found out how water from the air is constantly being returned to the land by precipitation. That is, water in the air is forever being returned to the Earth as rain, hail, snow, frost or dew.

You have also learned that water from the land is constantly being returned to the air by evaporation from lakes, rivers and sea, from the breath of animals and from the foliage of plants.

When the rate of evaporation is high and there is little precipitation, conditions will be dry.

Rainfall will be high in regions where winds carrying large amounts of water vapour are chilled.

When, where, and why these winds blow is discussed in ASEP's *Weather*.

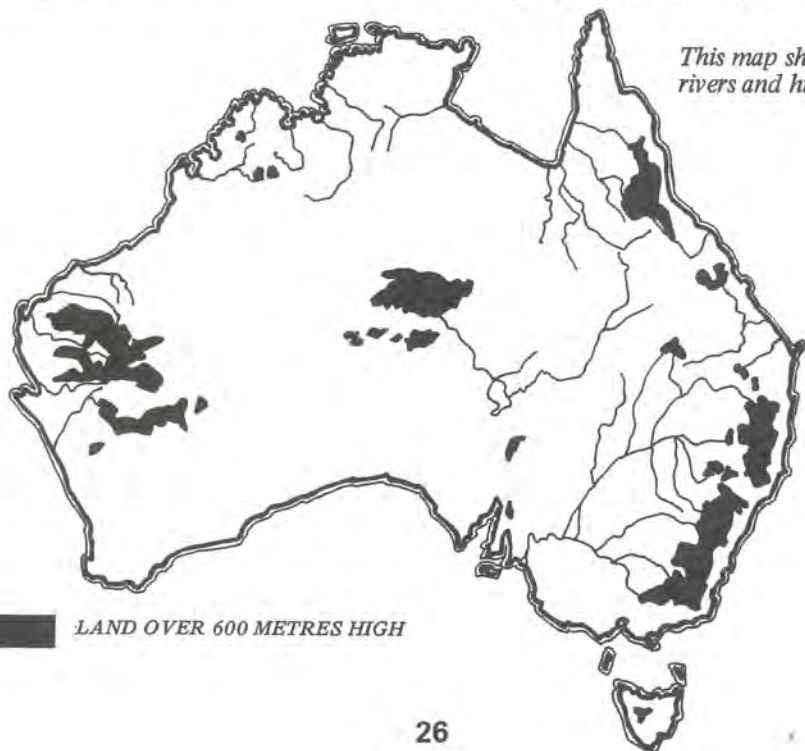
A country having a high rainfall will:

- Be in the path of such moisture-laden winds.
- Have conditions that cause the rain to form, e.g. high mountains can force winds upward to chilling regions where rain may form.

Neither of these conditions exists over most of Australia because:

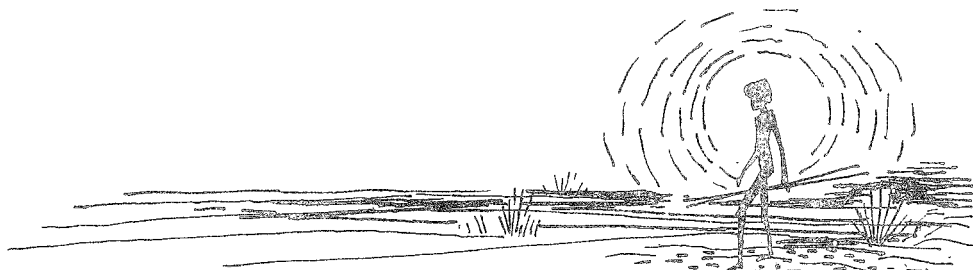
- Most of the continent is out of the paths of the main rain-laden winds.
- Australia has few high mountains. More than half the continent is less than 300 metres high and only about 5 per cent is more than 600 metres high.

As a result Australia has the low yearly rainfall of 430 millimetres. The average rainfall for the rest of the world is 660 millimetres.



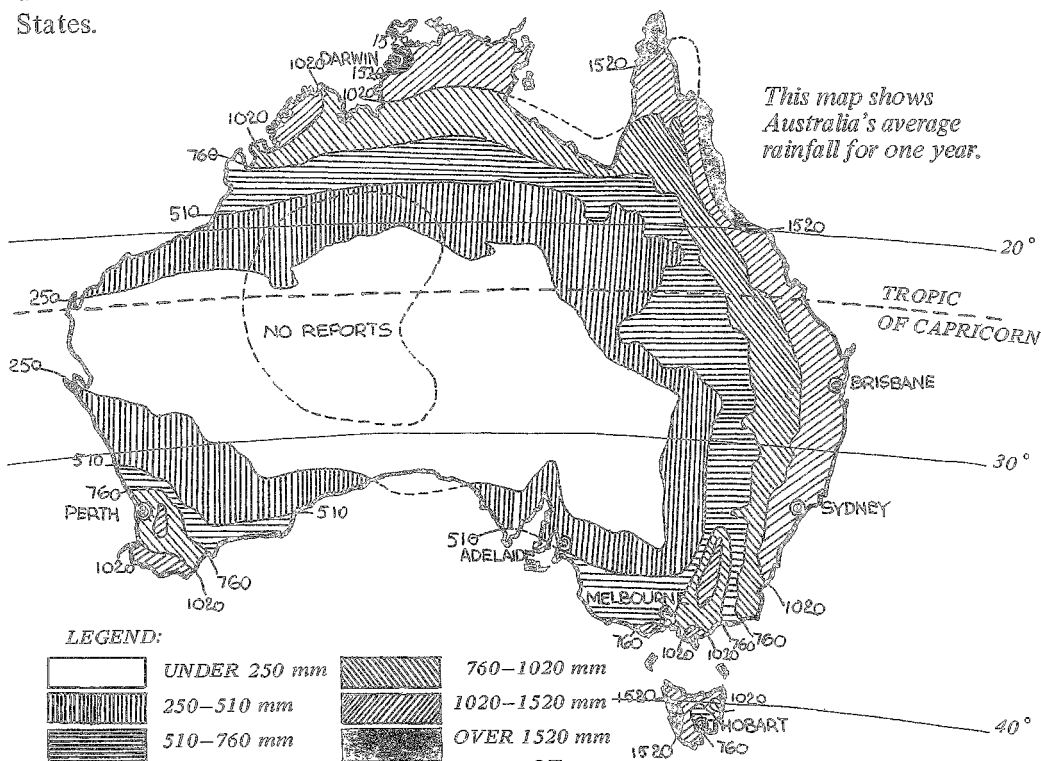
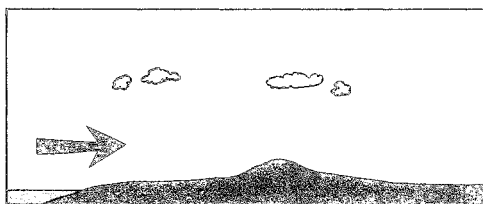
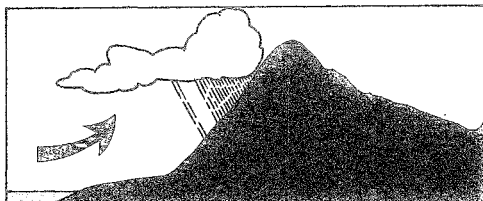
This map shows rivers and highland.

LAND OVER 600 METRES HIGH



Average rainfall figures do not give the complete picture because the rainfall is not regular each year. Sometimes some parts receive no rain for many years.

As well as this low rainfall, most of Australia has a high average temperature. This, combined with dry winds, causes surface water to evaporate rapidly. Therefore Australia has little available fresh water. One-third of Australia is desert and the desert extends into all the mainland States.



Test Yourself

Do you understand what you have been doing? This test has been written to help you find out, so it is important that all your answers are your own work. It is not a test for marks.

Answer the following questions on page 7 of your record book. For some questions, you have to choose the best answer from the several answers suggested. In each of these cases write only the letter of the answer which you choose.

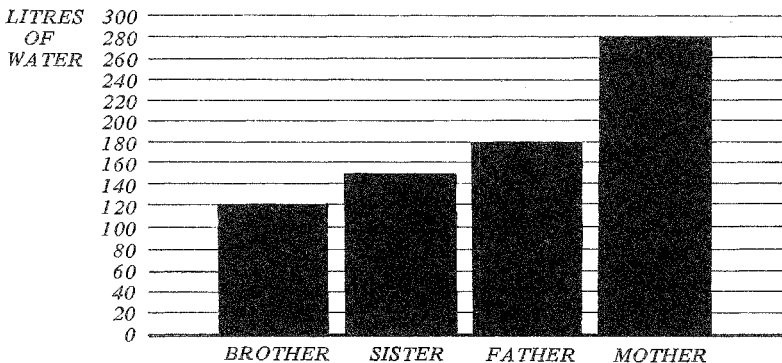
1 For this question you will need:

- several test-tubes and stoppers
- 1 test-tube rack
- 1 marking pen
- some liquids and solids which your teacher will supply.

Test each of the substances to see which are soluble in water. In each case, make, and record, three observations which help you to decide whether or not the substance is soluble in water.

- 2 Why is a mixture of starch in water called a suspension?
- 3 Man loses water from his body each day. What are the ways in which this water may be replaced?
- 4 Water is used by living things in many ways. Which of the following (one or more) do you think are some of these ways?
- A Water in the joints helps to lubricate them.
 - B Food and oxygen are carried in a watery solution called blood.
 - C Most chemical reactions occurring in living things do so in water solutions.
 - D Water swells cells.

Questions 5 and 6 refer to the bar graph below.



Ken wanted to find out how much water each member of his family used daily. The results of his investigation are shown in the bar graph on the opposite page.

- 5 How many litres of water did Ken's father use during the day?
- 6 How many more litres of water did Ken's mother use than his brother?

Questions 7 and 8 refer to the verse.

*In days gone by
It was hot and dry
The prunes had shrivelled up,
Said the king, 'You can marry
My eldest daughter Carrie
For a prune that fills a cup.'*

*Bold Sir Gwain
Had a cunning brain
He put a prune in water.
It swelled and swelled
So Gwain soon held
The hand of the king's daughter.*

- 7 The 'skin' of a prune is a semi-permeable membrane. What is a semi-permeable membrane?
- 8 Why does a prune swell when it is placed in water?
-

Questions 9 to 12 refer to the following diagram and information.

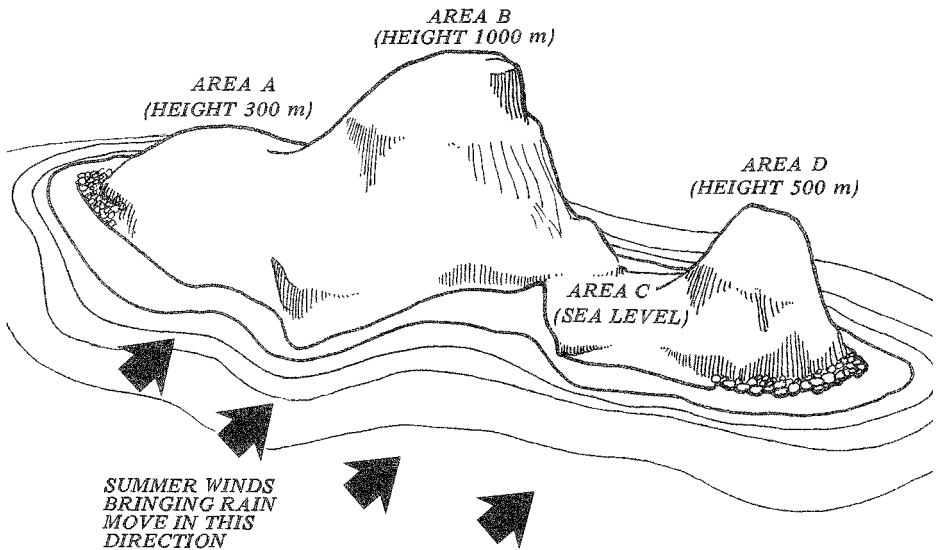


Choose your answer for each of questions 9 to 12 from this list of words.

- A Precipitation
- B Transpiration
- C Evaporation
- D Condensation
- E Infiltration

- 9 What is the process in which water in the liquid state is changed to water vapour?
- 10 What is the process in which water in the vapour state is changed to liquid?
- 11 What is the process in which liquid water is removed from clouds as rain?
- 12 What is the process in which water vapour is lost to the air by land plants?

- 13 Below is a diagram of a small island in the Pacific Ocean. This island lies in the path of the winds bringing summer rain, but it is found that one area of the island receives more rain than the rest. Which one of the areas would you expect to have the highest summer rainfall each year?



- 14 Why is the sea gradually becoming saltier?
- A Salt is continually being dissolved out of the rocks and sand on the ocean floor.
 - B When marine animals and plants die they decompose, leaving behind certain chemicals including salt.
 - C The polar caps contain large quantities of salt trapped in the ice, and this salt is continually being released into the sea as the ice of the polar caps gradually melts.
 - D Rivers continually carry dissolved salt into the sea and although the water evaporates the salt remains.
-

Now turn to the section called Check Your Answers on page 80 of this book.

ABOUT THE OPTIONS

These outlines will help you choose which options you want to do.



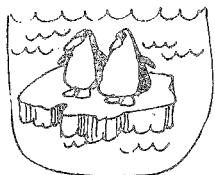
OPTION 1: UNDERGROUND WATER Page 32

In this option you find why artesian wells from the same underground basin may flow at different rates. You learn why it is sometimes dangerous to dispose of chemicals by burying them. You also find out something about Australia's underground water resources.



OPTION 2: WATER IN THE AIR Page 40

You make an instrument which indicates changes in the water content of the air.



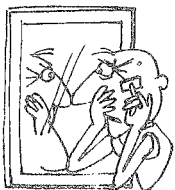
OPTION 3: NATURE'S THERMOSTAT Page 44

You investigate two reasons why water plays an important role in regulating world temperature.



OPTION 5: PLANTS GIVE OFF WATER Page 56

In this option you will learn one way of testing for water. This method is then used to test the liquid given off from a leafy plant.



OPTION 6: HARD WATER Page 59

You investigate one effect produced by certain materials that occur in water in various parts of the world.



OPTION 7: SURVIVAL ON LAND OR WATER ... Page 65

This option shows how you can increase your chance of survival if left in a desert or at sea without a supply of fresh water.



OPTION 8: POLLUTION IN WATER Page 68

This is a reading option. You make a survey of the causes of water pollution.

OPTION



In this option you find out why artesian wells from the same underground basin may flow at different rates. You learn why it is sometimes dangerous to dispose of chemicals by burying them, and you find out something about Australia's underground water resources.

Underground Water

What happens to rain water?

Some of it runs off in rivers to the sea, some of it is evaporated, but most of it seeps into the ground. In fact, most of the world's supply of fresh water is underground.

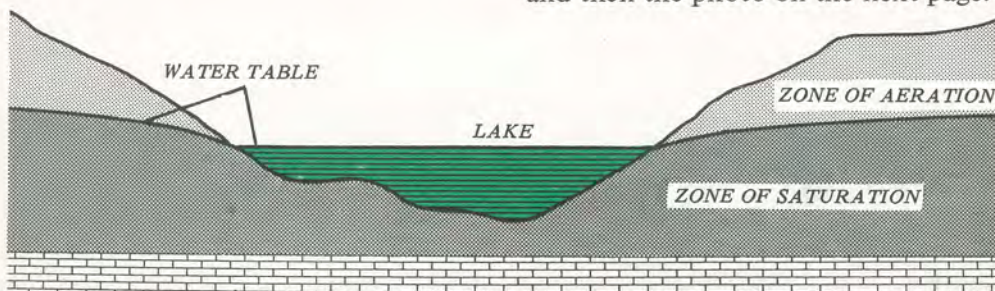
Much of the Earth's outer surface is made up of soil, a mixture of weathered rock, and decaying plant and animal material. Water can seep through soil.

Many of the rocks which can be seen at the Earth's surface are sedimentary rocks such as sandstone, limestone, and shale. Water can seep through many of these rocks, too. This layer of material through which water can seep is called a **pervious** (*PER-vee-us*) layer.

The seeping water moves downward until it meets a rock or clay layer through which it cannot pass (an **impervious layer**). Here, depending on the impervious layer's shape, the water either collects, or spreads through the ground.

Where rain water first seeps below the surface, the pores between the earth particles hold some water and some air. This is called the **zone of aeration** (*air-AY-shn*). Below this is the **zone of saturation**. Here the water has gathered and the space between the earth particles is completely filled with water. The top of the zone of saturation is called the **water table**.

Sometimes the water table may be seen above the surface of the land, as in lakes or rivers. Look at the diagram, and then the photo on the next page.



Cross-section of part of the Earth's crust to show a lake formation.



*Mutton Chop Lake
at Mt Gambier,
South Australia.*

MAKING A MODEL WELL

Sometimes, by digging, it is possible to dig below the surface of the water table and so form a well.

You can set up a model well in this activity.

You will need:

- 1 beaker, 50 ml
- enough fine gravel to fill the beaker
- 1 wooden spatula.

1 Fill the beaker almost to the brim with the gravel.

2 Add water until about three-quarters of the gravel is saturated.

3 Use the spatula to make a well in the gravel at the side of the beaker. It is easier to push the gravel aside than to dig it out.



4 Look through the glass at the well you have made. You should be able to see:

- ☐ The zone of saturation.
- ☐ The water table.
- ☐ The zone of aeration.

5 Now make a well in the centre of the gravel.



1.1 On page 8 of your record book, describe your well.

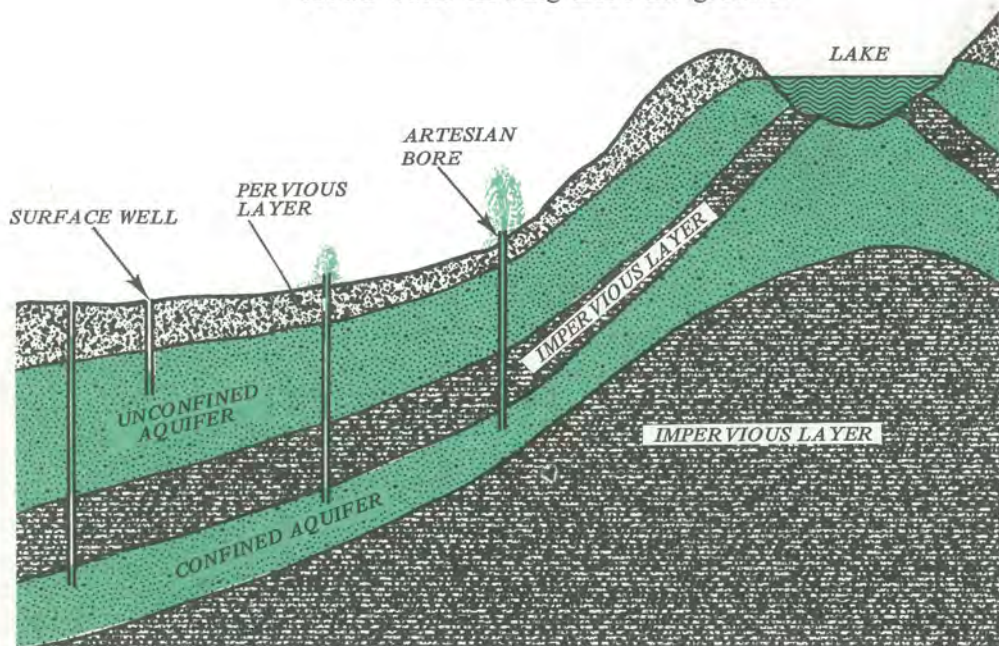
WHAT HAPPENS TO UNDERGROUND WATER?

Water that spreads through the ground eventually surfaces, or reaches the sea.

The layer of gravel or sand or other porous material through which water travels more freely than elsewhere through the earth is called an **aquifer**.*

Sometimes an aquifer is formed between two impervious layers, in such a way that the water is under pressure—like water in the pipes to a house. Study the diagram below.

Such an aquifer is called a **confined aquifer** and the water it contains is called **artesian water**. Artesian water is named after Artois, a province in northern France. There, in the twelfth century, well-diggers found water flowing from the ground.



Cross-section of part of the Earth's crust showing an aquifer, well and artesian bores.

The artesian bores in the diagram show that the water in the second bore hole is not spurting out as much as the water from the first bore hole. Water from the third bore hole would have to be pumped to the surface.

In the next activity, a model aquifer will help you to understand why this is so.

* The word 'aquifer' comes from two Latin words—*aqua* meaning 'water', and *ferre* meaning 'to carry'.

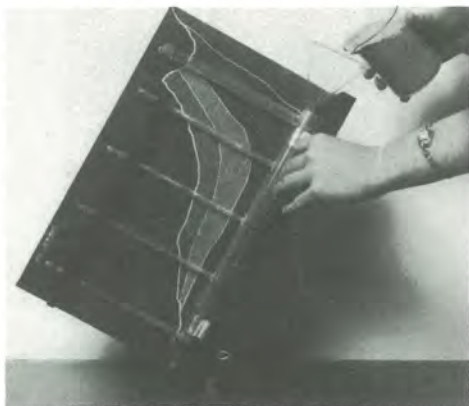
A MODEL AQUIFER

- 1 Remove the stopper from the inlet end of the aquifer tube and fill the tube with sand.
- 2 Re-stopper the aquifer tube.
- 3 Connect one end of the rubber tube to the aquifer outlet, and place the other end of the rubber tube over the sink.
- 4 Pour water from the beaker slowly into the aquifer inlet until the inlet tube is almost filled. As the water level sinks in the inlet tube, keep refilling the tube.

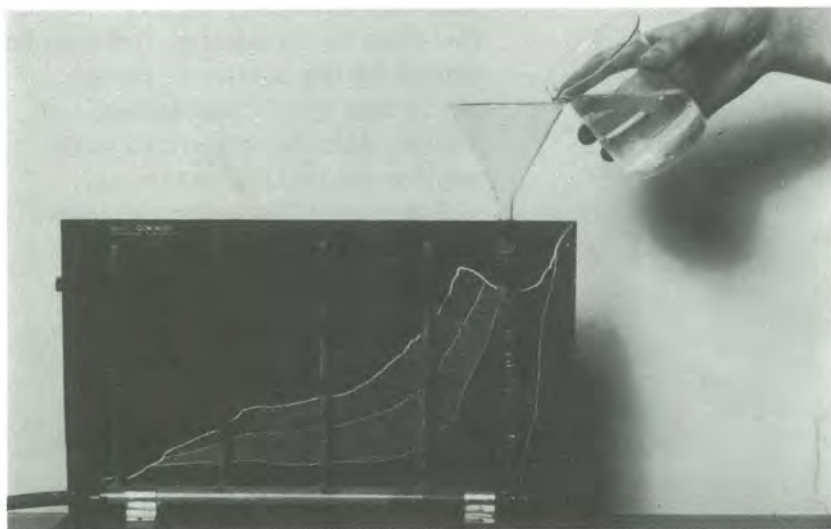
 1.2 Look at the height of the water levels in the bore tubes. Write your observations on page 8 of your record book.

You will need:

- 1 model aquifer
- 1 piece of rubber tubing about 25 cm long—to fit the aquifer outlet
- 1 beaker, 250 ml
- about 2 cups of sand.
- 1 funnel.



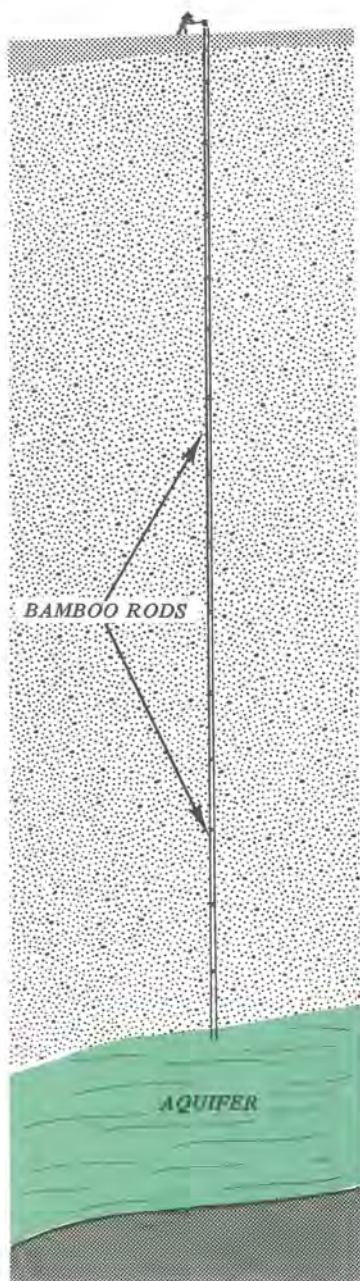
Filling a model aquifer with sand.



Filling a model aquifer with water.

When you have written your observations, read the explanation given in the Check Your Answers section on page 81 of this book.

Do not dismantle the model. You will need it for the next activity.



People used artesian water long before they understood where the water came from. Many centuries before Christ was born the Chinese used artesian wells to obtain water. They drove hollow bamboo stems more than 100 metres into the ground. This difficult task sometimes took more than 40 years to complete. Today bores are sunk much more quickly by using modern machinery and steel pipes.

WASTE DISPOSAL AND UNDERGROUND WATER

One way that some people get rid of dangerous waste materials from factories and chemical plants is to dig a hole in the ground and pour in the waste materials. If the waste materials seep into an aquifer they can poison the water in the aquifer, and even be carried by the aquifer to the sea where they again cause damage and kill life. Already in Australia some aquifers are polluted in this way.

There are other waste materials which interfere with an aquifer in a different way.

To show this you will need:

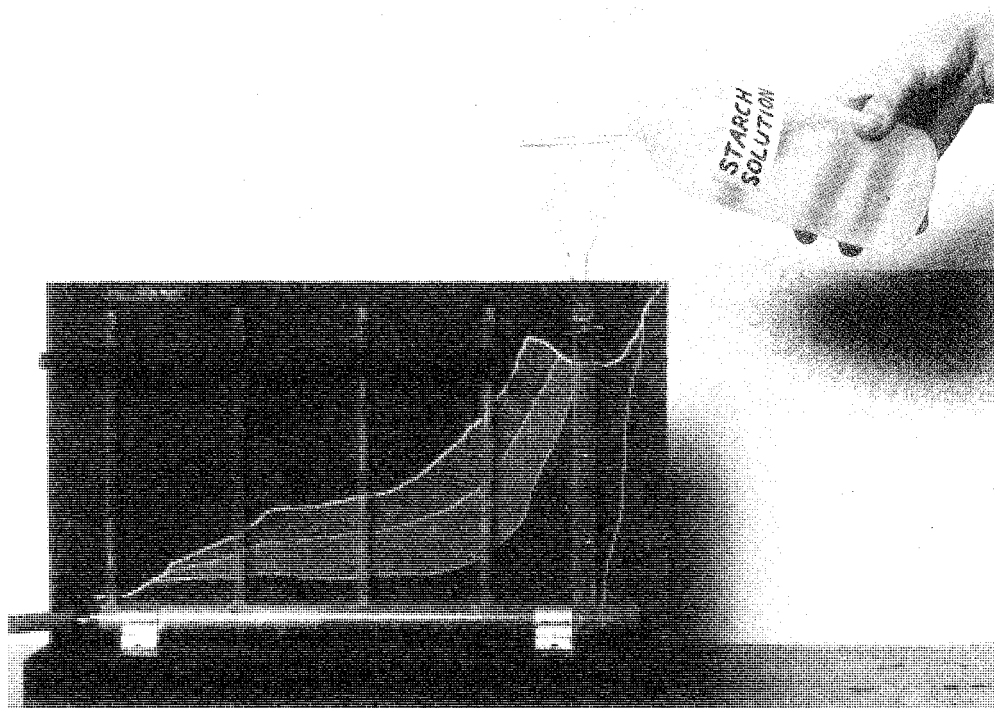
- the model aquifer you have already set up
- 1 bottle of starch suspension
- 1 funnel.

1 Allow all the water to drain from the model aquifer.

2 Hold the stopper on the bottle of starch suspension firmly in position. Shake the bottle to mix the starch and water together. Fill the aquifer inlet tube with the suspension.



1.3 On page 8 of your record book, write an explanation for what you observe.



Sometimes waste material poured into the ground blocks the pore spaces in an aquifer. It does this in the same way as the starch blocked the pore spaces between the sand grains in your model aquifer.

The waste material then continues to gather in the area in which it is dumped. Eventually the upper soil becomes saturated with polluted water.

This is only part of the pollution story. You can find out more about pollution in Option 8 (Pollution in Water).

Filling a model aquifer with starch solution.

FINDING UNDERGROUND WATER



A 'water diviner' or 'dowser' at work.

It is often difficult to know where underground water is stored.

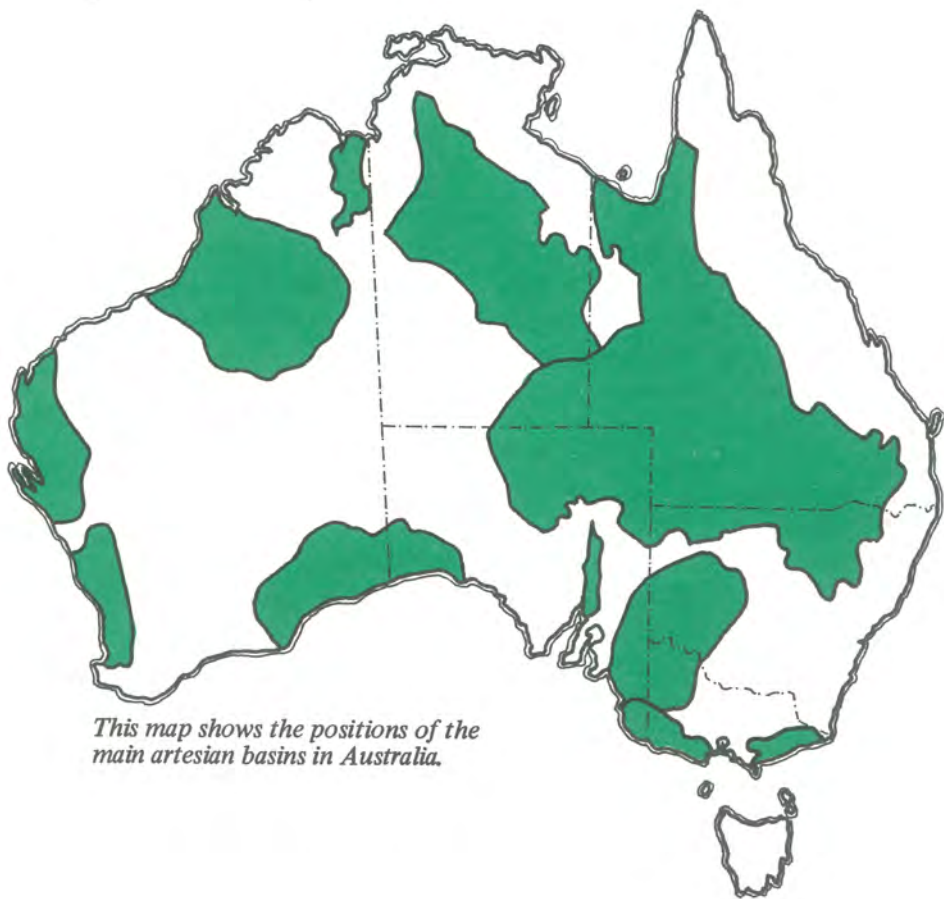
- Sometimes by seeing where water-loving plants are thriving, it is possible to guess that water is not far below the surface. (A desert oasis is an example of this.)
- Sometimes springs indicate a source of underground water.
- Sometimes by knowing the positions and shapes of impervious layers it is possible to guess the site of underground water.
- Sometimes people employ dowzers. A dowser is someone who claims to be able to find underground water by using a divining rod. The divining rod is usually a forked stick or a piece of wire bent in the shape of the letter 'Y'.

The dowser walks over the ground and claims that when he walks over underground water, the rod will bend in his hands and point downward.

The only way of knowing if the dowser's claim is correct is to sink a bore. This is costly. If a bore strikes water it is not worth the expense to see if the same water could have been tapped at a place passed over by the dowser. So we don't know whether the dowser has the ability he claims.

In Australia many bores have been sunk, and artesian water is now estimated to be under about two-thirds of the continent.

The positions of the main artesian basins are shown in the map below.



This map shows the positions of the main artesian basins in Australia.

You can check your answers on page 81 of this book.

OPTION



In this option you make an instrument which indicates changes in the water content of the air.

Water in the Air

In the first section of this book you saw that the air around you contained water in the form of gas or vapour.

The amount of water vapour in the air is not always the same. When the air contains a lot of water vapour the weather is said to be **humid**. Under humid conditions perspiration doesn't evaporate readily.

We rely on the evaporation of perspiration for cooling our bodies. When the evaporation doesn't occur readily, we feel hot and sticky.

We can also detect changes in the amount of water vapour in the air by using a material that changes in some way when the amount of water vapour in the air changes.

A human hair is affected by moisture in the air. When the air is moist the hair becomes longer. When the air becomes drier the hair shortens.

MAKING A MOISTURE MEASURER

Moist hair is only slightly longer than dry hair. Your measurer must make the small change appear much bigger.

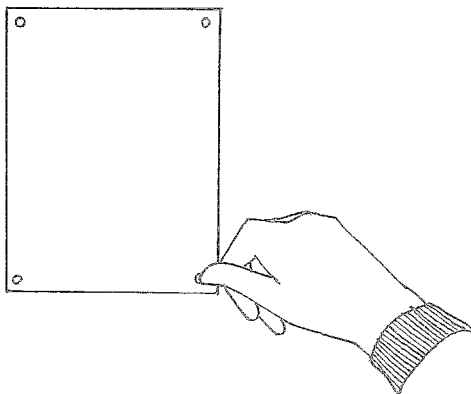
You will need:

- 1 rectangle of cardboard, about 15 cm x 12 cm
- 1 cardboard strip, about 8 cm x 5 cm
- 5 drawing pins
- 1 human hair, about 15 cm long
- 1 pair of tweezers
- 1 bottle of ammonia solution
- 1 watch-glass
- adhesive tape.



WARNING: Ammonia fumes irritate the nose lining so do not inhale them.

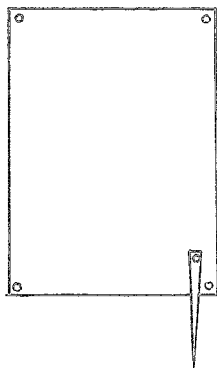
1 Pin the large rectangle of cardboard to a vertical wall board.



2 Cut the cardboard strip in the shape of a pointer.

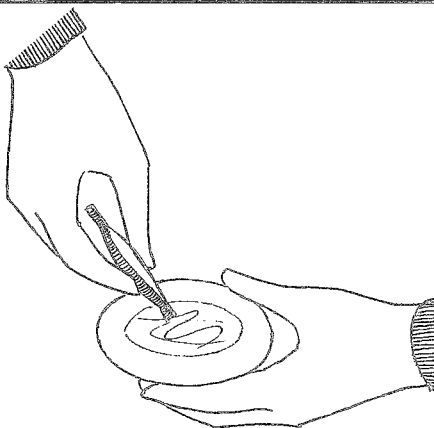
3 Pierce the blunt end of the pointer with one of the drawing pins.

4 Pin the pointer about 5 centimetres up from the bottom right-hand corner of the cardboard rectangle and about 1 or 2 centimetres in from the side as shown. Make sure the pointer can swing freely.

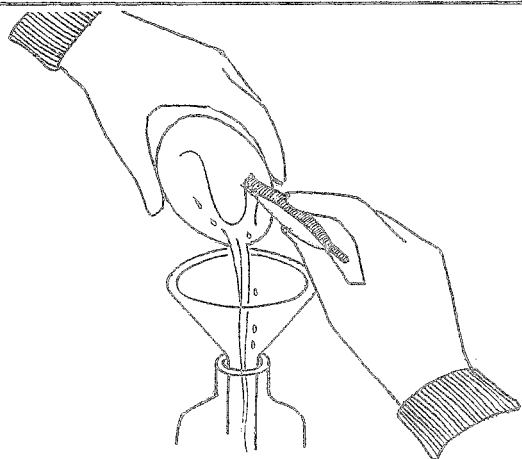


5 Place the hair on the watch-glass and pour some of the ammonia solution over the hair. Shake the watch-glass gently so that the solution washes the hair. The washing removes oil, which may prevent the hair from absorbing water.

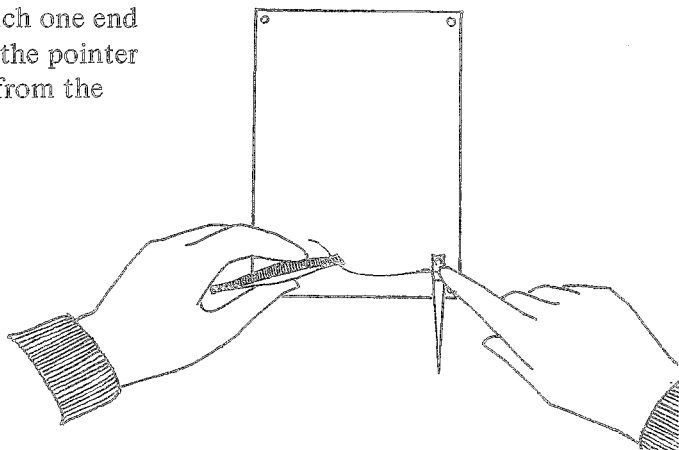
Use the tweezers to handle the hair after it has been washed. Even clean hands have oil from the skin on them.



6 Hold the hair with tweezers and pour any remaining solution into a waste bottle provided.

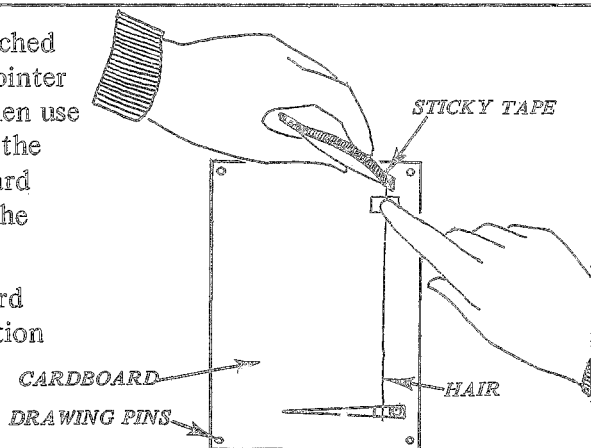


7 Using the tape, attach one end of the cleaned hair to the pointer about 0.5 centimetre from the drawing pin.



8 Hold the hair by its unattached end, and use it to draw the pointer into a horizontal position. Then use tape to attach the top end of the hair to the top of the cardboard rectangle in such a way that the hair is vertical.

9 Put a mark on the cardboard rectangle to indicate the position of the pointer.



Instruments which indicate changes in the amount of water vapour in the air are called **hygrometers** (*hie-GROM-eters*). You have just made a **hair hygrometer**.

MARKING THE HYGROMETER

Find the position of the pointer when the hygrometer is placed in dry air. You can use a desiccator to provide dry air. A desiccator (see diagram) is a sealed vessel containing a chemical that absorbs water from the air. Usually the chemical is calcium chloride or silica gel (*SIL-ik-a JEL*).



Leave the hygrometer overnight in the sealed desiccator. Next day, remove the hygrometer, and pin it to the vertical wall board. Mark the position of the pointer. Label this mark 'Dry'.

Find the position of the pointer when the hygrometer is placed in moist air.

Hold the hygrometer above boiling water for about two minutes. Then pin it to the vertical wall board.

Make the position of the pointer and label the mark 'Wet'.

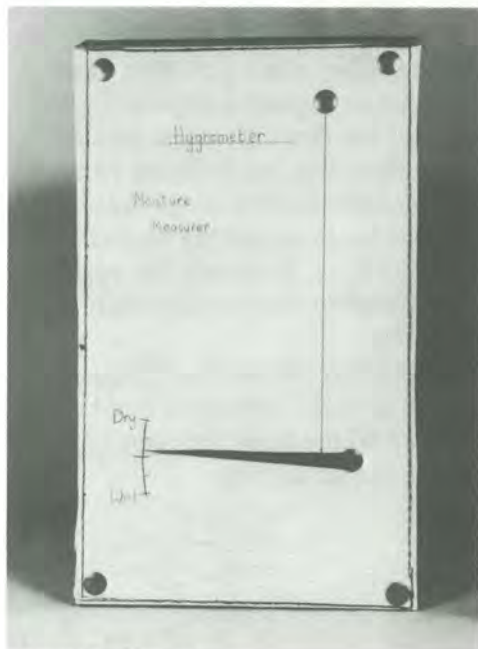
FURTHER ACTIVITIES

1 You may be able to take the hygrometer home to test the humidity of various rooms. You could test the kitchen, the living-room, or the bathroom after someone has just taken a shower.

2 You could find out what happens to the pointer when the weather changes.



2.1 On page 9 of your record book, explain why the pointer moves upward after fog.



A hair hygrometer.

You can check your answer to 2.1 on page 81 of this book.

OPTION



You investigate two reasons why water plays an important role in regulating world temperature.

Nature's Thermostat

SAND AND WATER

Have you ever noticed on a summer's day when you have been at the seashore, walking over rocks, and through the lapping waves, that the rocks often feel much hotter to your feet than the surface of the water? Yet the Sun has been shining on both for the same time. Evidently the rocks reach a higher temperature than the water.

Would this still be true if equal masses of rocks and water had been exposed to the Sun? You can find the answer in this activity.

You will need:

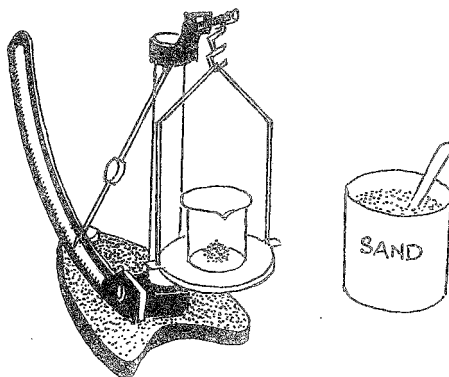
- 1 test-tube rack
- 2 test-tubes
- 2 thermometers, -10°C – 110°C
- 1 teaspoon of sand
- 1 teaspoon
- 1 beaker, 100 ml
- 1 dropper
- a balance—to measure equal masses of water and sand.

Note. For this activity you will be using a balance. Not all balances are operated in the same way. If you are not sure how to use the balance, ask your teacher before starting the activity.



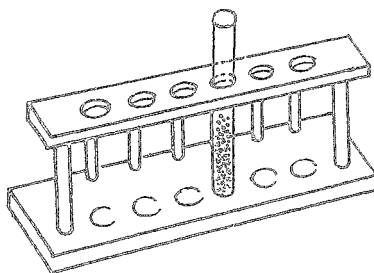
1 Add one heaped teaspoon of sand to the beaker. Then stand the beaker on the balance pan.

2 Make the necessary adjustments to balance the beaker of sand.



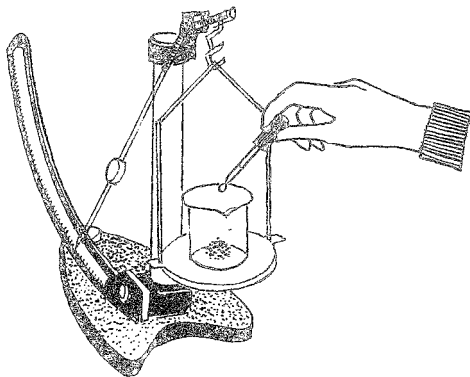
3.1 On page 9 of your record book, record the mass of the beaker plus sand.

3 Leave the balance set up, but pour the sand into one of the test-tubes. Then stand the test-tube in the rack.



4 Add two teaspoons of water to the beaker and return the beaker to the balance pan.

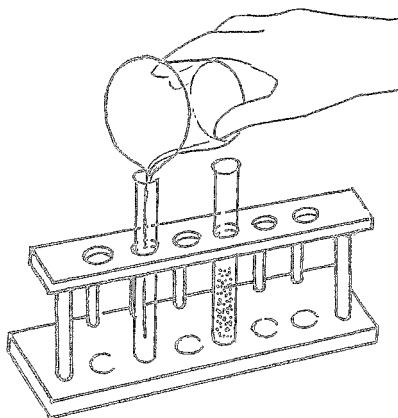
5 Use the dropper to add or remove water until you have the same state of balance as before.



3.2 What is the mass of the beaker plus water?

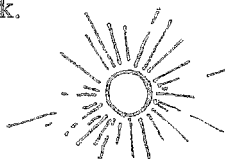
6 Pour the water from the beaker into the empty test-tube. Then stand this test-tube in the rack.

You now have equal masses of water and sand.



7 Place a thermometer in each test-tube. Make sure the bulb of each thermometer is covered by the substance in the tube.

 Record the reading of each thermometer in Table 3 on page 9 of your record book.



8 If the Sun is shining, place the rack containing the test-tubes and thermometers in the sunshine. Position the rack so that each test-tube receives the same amount of sunshine.

On an overcast day or in winter, you may get quicker results by placing the rack about 10 centimetres from a 100 watt light globe.

9 Watch the thermometers.

 After eight minutes, record the temperature of each thermometer in Table 3.

10 Remove the rack from the heat source.



Complete Table 3.



3.3 Write your conclusions on page 9 of your record book.

When equal masses of water and sand were exposed to the same source of heat for the same time, the temperature of the water rose less than that of the sand.

This is true not only for sand but for most other substances, too.

On the other hand, when water cools its temperature drops much more slowly than that of sand.

In this way water plays an important part in lessening extremes of temperature throughout the world.

When heated by the Sun, the Water's temperature rises much more slowly than that of the land and so the water is still cool when the land is hot. Heat is then transferred from the land to the waters of seas, lakes and rivers. So the land becomes cooler and the water warmer.

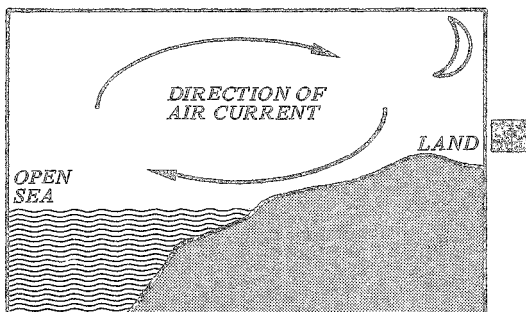
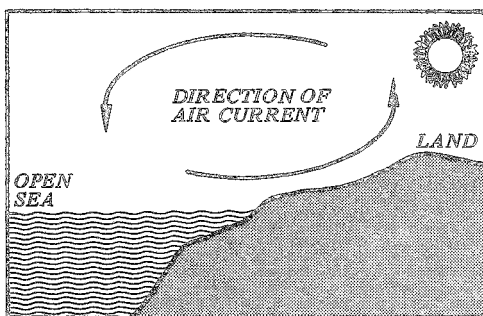
Water takes longer to cool than land. By the time the land is cool, the water is still comparatively warm. Heat is then transferred from the water to the land.

There are other ways in which water plays a part in lessening extremes of temperature.

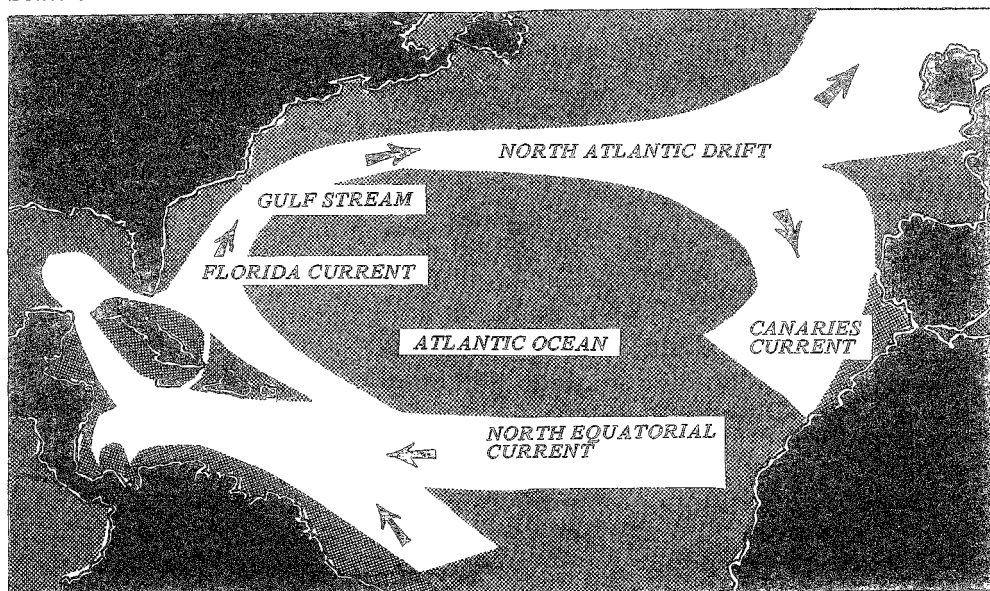
□ Warm water in the tropic oceans is carried by ocean currents to cooler regions. It affects the climate of these regions.

One current of warm water is called the Atlantic Gulf Stream. It warms the British Isles and parts of Norway. However, Labrador, the same distance north of the Equator, is icy because it is away from the Gulf Stream on the western side of the Atlantic Ocean.

Some ocean currents.



In the next activity you find another reason why water plays an important part in lessening temperature extremes.



LATENT HEAT

If someone said he suspected you had a **latent** ability for music, he would mean you had a musical ability that was hidden, and as yet undeveloped.

When a material has **latent** heat, it has hidden heat that can be released under certain conditions.

This activity is about latent heat.

You will need:

- 1 beaker, 100 ml
- 1 ice cube
- 1 clock (or watch)
- 1 thermometer, -10°C – 110°C
- 1 cloth—about handkerchief size
- 1 hammer.

Break the ice cube into small pieces by wrapping it in the cloth and hitting it with the hammer. Then place the crushed pieces in the beaker.

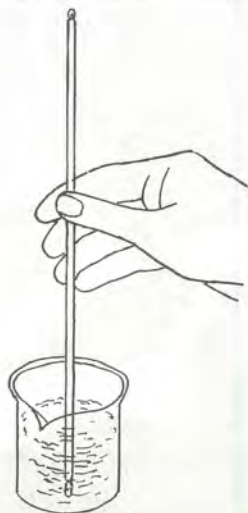


 Place a thermometer in the beaker and record the temperature of the ice pieces in the column for 'O' minutes in Table 4 on page 10 of your record book.

 Keep the thermometer in the beaker. Every minute gently stir the melted ice and ice pieces with the thermometer, and record the temperature. Enter your results in Table 4.

 In Table 4, put a cross against the time at which the last of the ice melts.

 Keep taking and recording the temperature readings every minute for another six minutes. Enter the results in Table 4.



On the graph paper on page 10 of your record book, plot a graph showing how the temperature changed with time.

 3.4 Consider your results and write your conclusions on page 11 of your record book before reading on.

Warm air in the room heated the ice and water. The water and ice were being warmed from the beginning of the activity. Yet the temperature did not rise until all the ice had melted.

Heat was used in changing ice at 0°C to water at 0°C . The flat section on the graph shows how long the ice and water absorbed heat without a change in temperature.

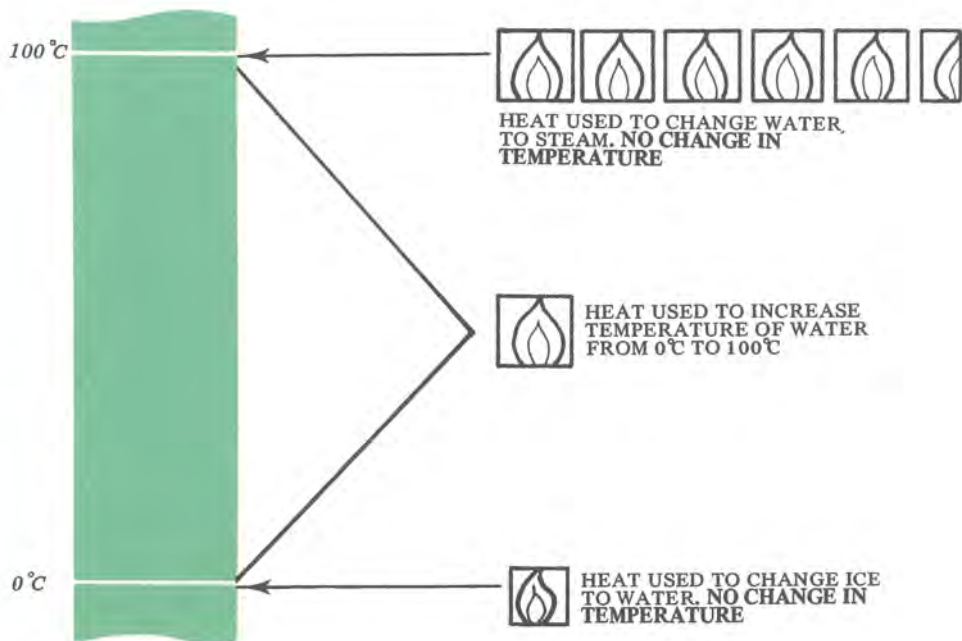
Once all the ice had melted, the temperature of the water rose quickly. This is indicated by the

sloping part of the graph.

If you carefully measured the amount of heat used to change ice to water, and then to steam, you would find two things.

- It takes nearly as much heat to change ice at 0°C to water at 0°C , as it does to heat the same amount of water from freezing point (0°C) to boiling point (100°C).
- It takes about five-and-a-half times as much heat to change water at 100°C to steam at 100°C as it does to heat the same amount of water from freezing point to boiling point.

If steam is cooled until it becomes ice, the changes take place the other way round. That is, steam at 100°C changing to water at



100° Celsius gives out about five-and-a-half times as much heat as water does in cooling from 100° Celsius to 0° Celsius. This is why a burn caused by steam is much worse than a burn caused by water.

A change of state occurs when a material changes from solid to liquid or from a liquid to gas or vice versa.

Heat given out or absorbed during changes of state is called latent heat.

The latent heat of water is important in lessening extremes of temperature throughout the world. When water is evaporated by the tropic warmth, large amounts of

latent heat are absorbed from the surroundings. Consequently these surroundings are cooled.

(Remember the effect of allowing methylated spirit to evaporate on your skin?)

When the water vapour condenses, the latent heat it contains is released. This heat warms an air mass which may travel to distant regions.

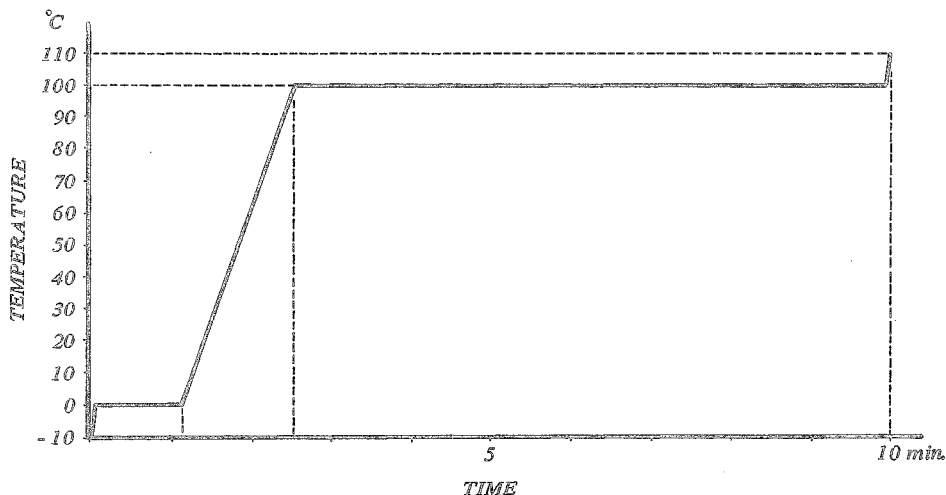


3.5 Why does a 'freezing brick' keep the contents of a portable refrigerator cool? Write your answer on page 11 of your record book.

You can check your answer on page 82 of this book.

Here is something to think about and then discuss with other students.

In an experiment, a scientist placed a small quantity of ice, at a temperature of -10°C, in a large, closed container. The container held nothing but ice. Heat was supplied at a steady rate. The scientist drew a graph showing the temperature of the contents at various times. A simple version of his graph is reproduced below.



What information can you obtain from the graph?

OPTION



Solid yes
but c-o-l-d.

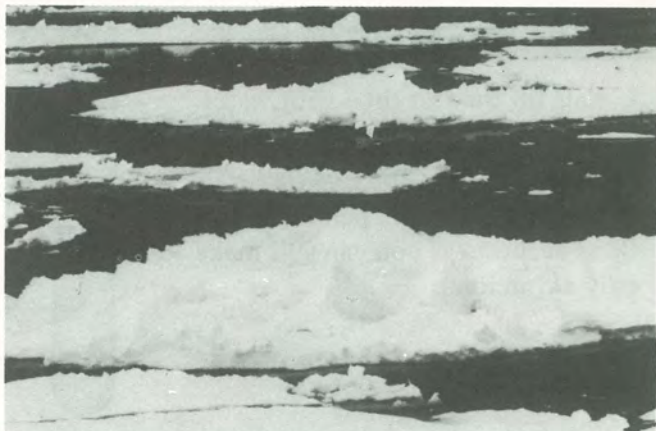


In this option you
find out why ice
floats on water.

Solid Water

The photos show
ice either floating,
or on top of water.
Why does ice float?

To answer this
question you need
to find what
differences between
ice and water cause
ice to float.



Icebergs floating in the sea.

(By courtesy of ANARE.)



Photo of frozen lake.

DIFFERENCES BETWEEN ICE AND WATER

Some of the differences between ice and water can be seen, some can be felt.

Collect a small piece of ice in a beaker.



4.1 Look at and feel the ice and water. On page 12 of your record book, list all the differences you can find between them.

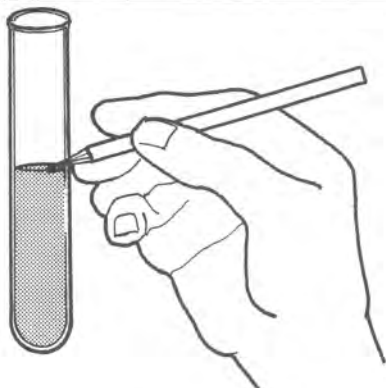
There are other differences, too. Here is a way to find an important difference that can't be seen.

You will need:

- 1 small test-tube
- 1 beaker, 250 ml
- enough ice chips to half fill the beaker
- 1 marking pen
- 5 teaspoons of table salt.

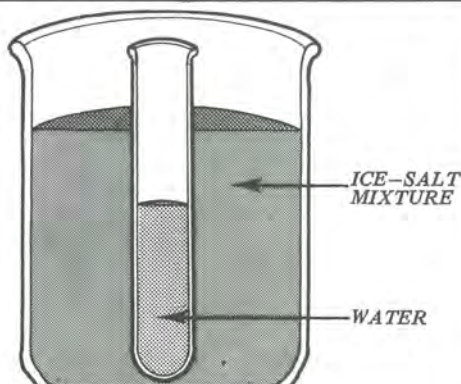
1 Half fill the test-tube with water.

2 Hold the test-tube vertically and mark on the glass, the surface height of the water. Use the pen to do this. Be as accurate as you can and make only a thin line.



3 Mix the ice and salt together. Pack this mixture around the test-tube, which should be upright in the centre of the beaker.

4 Wait several minutes until the water in the test-tube is frozen solid.



CUT AWAY DIAGRAM

5 Take the test-tube from the ice and examine the level of ice in it.

 4.2 Is the level the same as before, or is it greater or less than before? Write your answer on page 12 of your record book.

The water expanded on freezing. That is, the space it occupies (volume) is greater than before. However, as you haven't added or removed any material from the tube, the weight of ice must be the same as the weight of the water with which you started.

If the water weighed three weight units before freezing, the larger volume of ice still weighs three weight units.

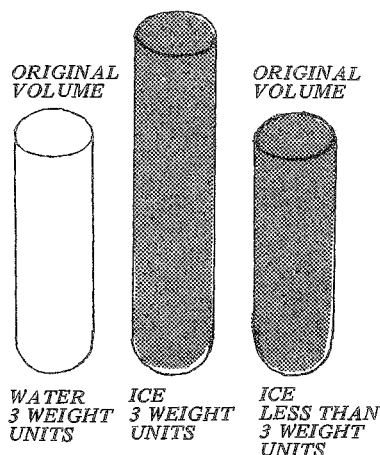
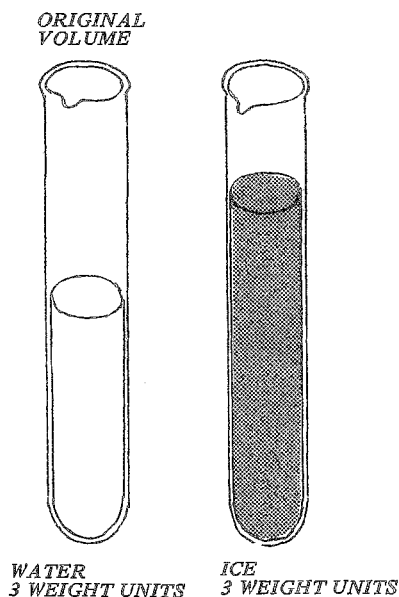
If the larger block of ice is cut back to the size of the original volume of water, the ice that is left must weigh less than three weight units.

So ice must weigh less than an equal volume of water.

 Add this to your list of differences between ice and water.

Read the list of differences. Is it this last difference that causes ice to float? Does a substance lighter than an equal volume of water float?

In the next activity, you will find more evidence to help you answer this question.



WHICH SUBSTANCES FLOAT?

You will need:

- 4 equal-sized cubes made from wood, aluminium, polystyrene foam, and brass
- 1 bucket into which the cubes fit exactly
- 1 spring balance
- 1 plastic or metal beaker, 250 ml.

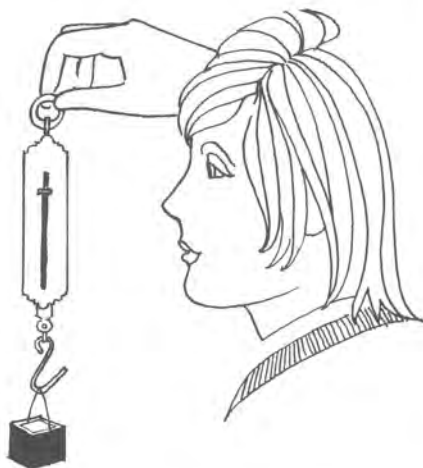
Notice that all the blocks exactly fit the cavity of the bucket.



Use the spring balance to find the weight of the bucket.



Record this and the other results you will obtain in Table 5 on page 12 of your record book.



Place the brass cube in the bucket. Use the spring balance to find the weight of the bucket and cube.



Record this result in Table 5.

Subtract the weight of the bucket from the weight of the bucket and cube.



4.3 What does this answer give you? Enter this result in the appropriate space in Table 5.



In the same way find and enter the weights of the other cubes.

Fill the bucket with water. Dry the outside of the bucket.



As before, calculate the weight of the bucket's contents, this time a cube of water. Enter your result in Table 5.

Compare the weight of each solid cube with the weight of the cube of water.



Then fill in column 5 of Table 5.

You now know which cubes are heavier and which cubes are lighter than an equal volume of water.



4.4 Guess which cubes will float in water and which will sink. Write your answer on page 13 of your record book.

Check your guess by putting the cubes one at a time into a beaker three-quarters full of water.



Then fill in the last column of Table 5.



4.5 On page 13 of your record book, fill in the missing words in the two sentences. (Hint: Refer to columns 5 and 6 of Table 5.)

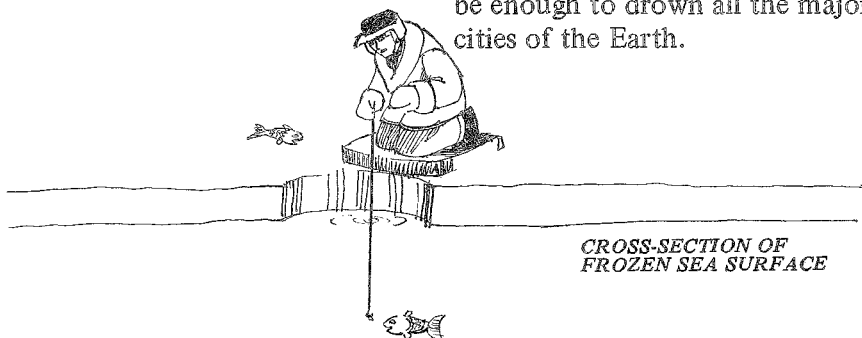
Materials that weigh less than an equal volume of water float. This is why ice floats. In Activity 1 of this option you saw that ice weighs less than an equal volume of water because water expands when it turns to ice.

Almost all substances contract on cooling. Water contracts on cooling too, but only until a temperature of 4° Celsius is reached. When cooled from 4° Celsius to 0° Celsius, water expands.

This expansion on cooling is peculiar, but very fortunate for life. Because of it cold water rises to the surface as freezing point is approached.

When ice forms on the top of a pond there is warmer water farther down where plant and animal life may survive. Of course if it becomes too cold the whole pond or river will freeze. Although there is ice in the polar seas, there is still life in the water below the ice.

There is another reason why it is fortunate for us that ice floats. If all the ice in the world sank below the seas, the sea level would rise by between 30 and 60 metres. This would be enough to drown all the major cities of the Earth.



You can check your answers on page 82 of this book.

OPTION



In this option you can find out one way of testing for water. This method is then used to test the liquid given off from a leafy plant. You could do this option at home and report your discoveries to the class.

Plants Give Off Water

On page 24 (The Great Water Cycle) and on page 26 (Australia, the Driest Continent) you read about the importance of plants transferring water from the ground to the air.

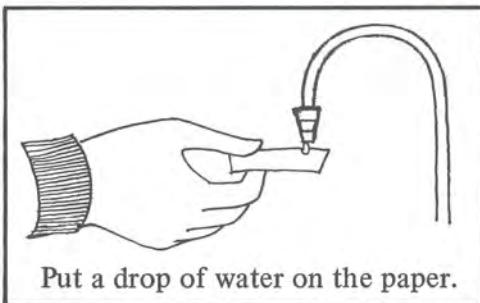
This activity shows how you can prove that plants give off water to the air.

First you need to know how to test for water.

Cobalt(II) chloride is a chemical which changes colour when it comes in contact with water. For testing, you can use a strip of filter paper that has been soaked in a cobalt(II) chloride solution, and then dried. The strips should be kept in a sealed bottle to keep them dry.

Tear a small piece of cobalt(II) chloride paper from one of the strips—1 centimetre is enough. Then put the lid back on the bottle to protect the remaining paper from any dampness in the air.

 **5.1** What colour is the dry cobalt(II) chloride paper? Write your answer on page 13 of your record book.



 **5.2** What colour is the wet cobalt(II) chloride paper?

Water is the only substance that causes cobalt(II) chloride to change colour like this so you can use this colour change as a test for water.

You will need:

- 1 dry plastic bag
- 1 rubber band.

1 To test whether plants transfer water from the ground to the air, go outside and cover the leafy end of a branch with the plastic bag, as shown.

Use a cut rubber band to tie the open end of the bag tightly around the branch.

2 Examine the bag each hour until you see drops of liquid inside the bag. As this will take some time you could go on with another option.



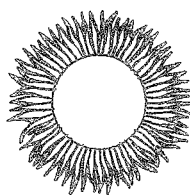
3 When you finally see drops of liquid in the bag, get a small piece of dry cobalt(II) chloride paper.

Remove the bag and rub the cobalt(II) chloride paper in the drops of liquid.

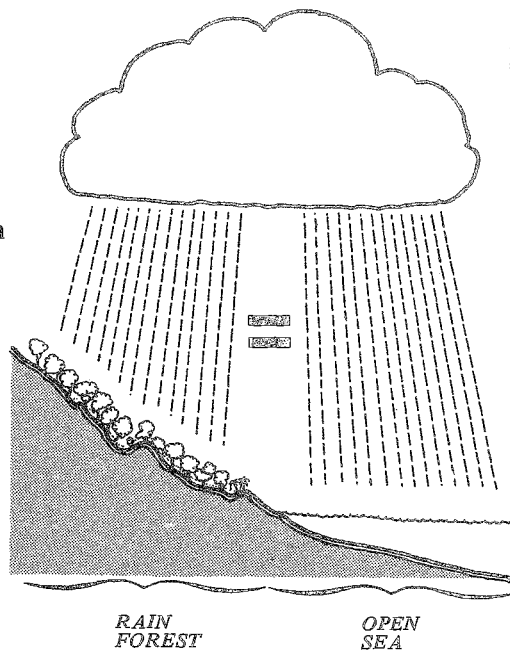


5.3 What is the liquid?

Write your answer on page 13 of your record book.



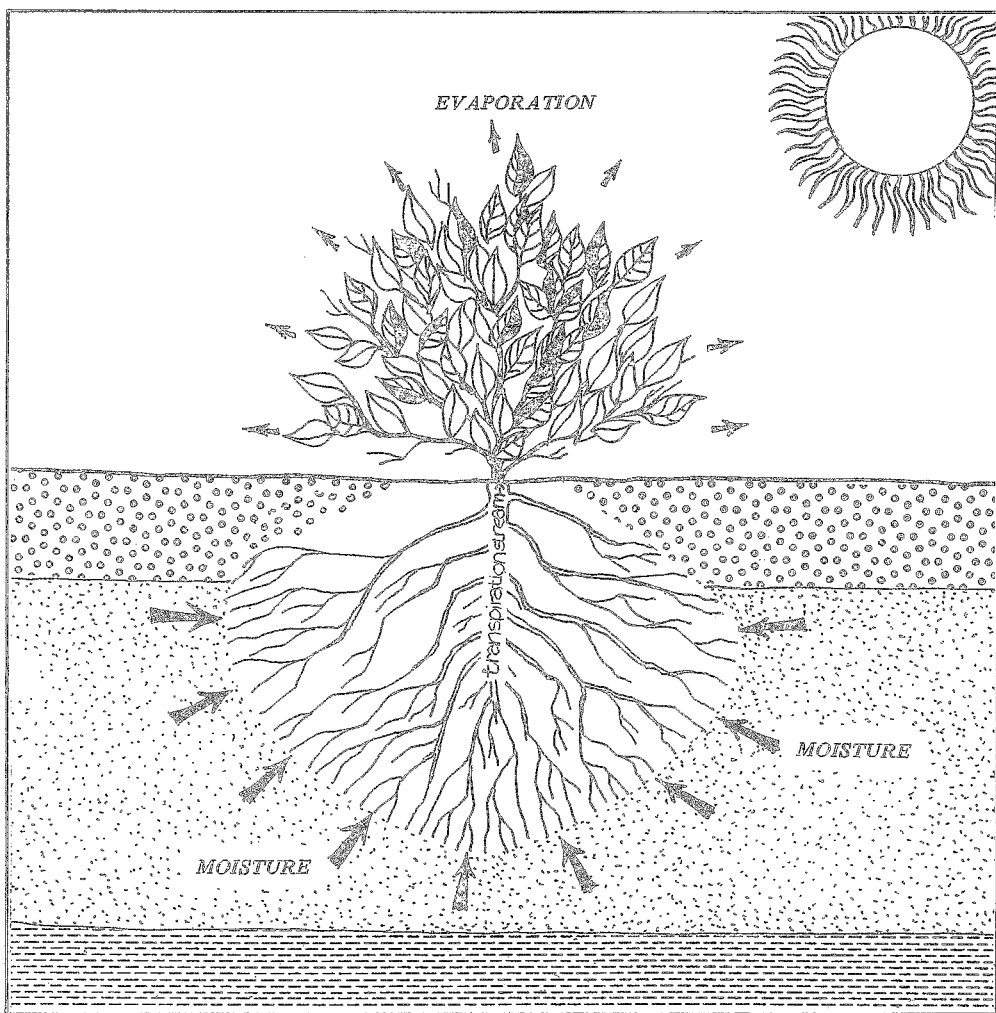
Plants actually pass large amounts of water into the air. A tree may pass as much as 200 to 300 litres of water into the air in one day. The plants of a rain forest actually pass as much water into the air as is evaporated from the same area of open sea under the same conditions of wind and temperature.



The water that the plant passes into the air comes from the ground. The roots of the plant take up ground water. This water passes up the stem to the leaves. From here the water evaporates into the air. This passage of water from ground to air through the plant is called the transpiration stream.

The chemicals that are dissolved in the ground water are thus distributed throughout the plant, and in this way the transpiration stream acts as a sort of plant blood stream. The water evaporating from the leaves cools the plant in much the same way as sweat evaporating from animals cools them.

You can check your answers on page 82 of this book.



OPTION



You investigate one effect produced by certain materials that occur in water in various parts of the world.

Hard Water

As water flows over and through the ground, many materials dissolve in it. In many parts of the world, water contains one or more of the following dissolved materials:

- ☐ calcium sulphate,
- ☐ magnesium sulphate,
- ☐ calcium chloride,
- ☐ magnesium chloride,
- ☐ calcium bicarbonate, or
- ☐ magnesium bicarbonate.

Often the amount of these chemicals which dissolves is small and the water is still suitable for drinking. But these dissolved chemicals stop soap from removing grease and dirt, and from lathering easily with water.

Water which doesn't lather easily with soap is called **hard water**. Soft water lathers easily.

In many parts of Australia, the only available water is hard water.

*It's not that I'm dirty mum
It's the hard water*



HARD AND SOFT WATER

In this activity, you will be able to compare the hardness of water from your local supply with the hardness of other water samples.

Three samples of water are provided by your teacher.

- Sample 1 is distilled (pure) water.
- Sample 2 is water made hard by calcium bicarbonate.
- Sample 3 is water made hard by magnesium sulphate.

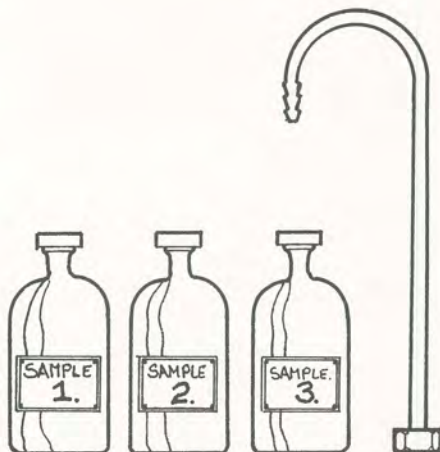
1 Wash the test-tubes and dry their outsides.

2 Use the pen to number the test-tubes 1 to 4.

- Use test-tube 1 for collecting 2 to 3 millilitres of sample 1.
- Use test-tube 2 for collecting the same amount of sample 2.
- Use test-tube 3 for collecting the same amount of sample 3.
- Use test-tube 4 for collecting the same amount of tap water.

You will need:

- 4 test-tubes
- 1 test-tube rack
- 1 teaspoonful of soap flakes
- 1 marking pen
- 4 stoppers—to fit the test-tubes.

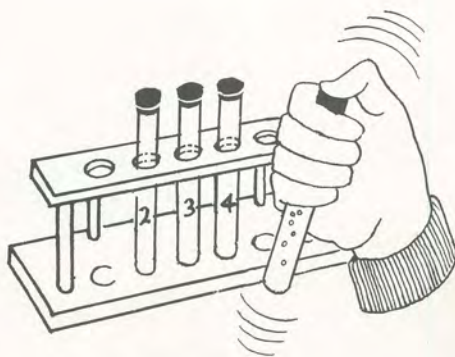


3 Add one soap flake to the sample in test-tube 1. Put a stopper on the test-tube.

4 Hold the test-tube with your thumb over the stopper. Shake the test-tube 15 times.

5 If no lather occurs, add another soap flake and repeat the shaking.

6 Repeat steps 4 and 5 until a lather appears.





In Table 6 on page 13 of your record book, note the number of soap flakes needed to produce a lather.

7 To each test-tube add a soap flake. Repeat steps 4, 5 and 6.



Record the results in Table 6.

The number of soap flakes used indicates the hardness of the water. The harder the water, the more soap flakes you need to produce a lather.



6.1 On page 14 of your record book, list the samples in order from the least hard sample to the most hard.

Note: You can eventually form a lather by adding soap to hard water. The added soap will eventually soften the water, but this would waste soap and money.

It's better to find other methods for removing the hardness from water. You can try another method in the next activity.



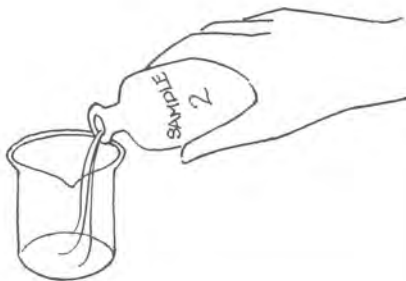
BOILING HARD WATER

Does boiling alter the hardness of water? You can find out in this activity.

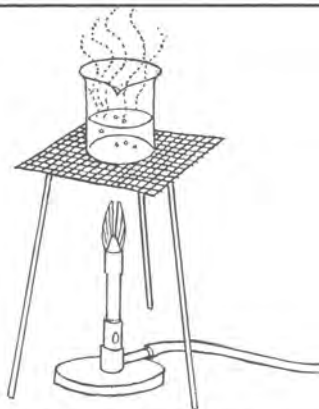
You will need:

- 1 beaker, 100 ml
- 1 heater
- 1 stand
- 1 gauze mat
- 1 teaspoonful of soap flakes
- 1 clean test-tube and stopper.

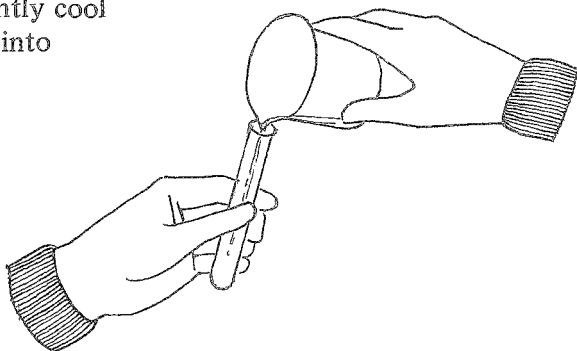
- 1 Pour some of water sample 2 into the beaker to a depth of about 2 centimetres.



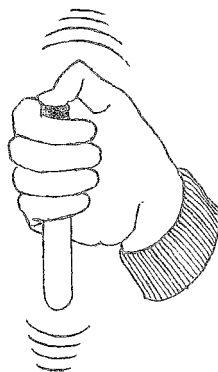
- 2 Set the beaker containing the hard water sample on the gauze mat on the stand.
- 3 Light the heater and boil the water for two or three minutes, then allow the water to cool.



4 When the water is sufficiently cool pour about 3 millilitres of it into the test-tube.



5 Add soap flakes, one at a time, to the test-tube. Stopper the test-tube and shake it 15 times after adding each flake. Compare the number of soap flakes required to produce a lather after boiling water sample 2 with the number required before boiling.



6.2 What effect did boiling have on the hardness of the water? Write your answer on page 14 of your record book.



6.5 What chemical did water sample 3 contain?

When the hardness can be removed by boiling, the water is called temporarily hard water.

Temporary hardness is due to the presence of calcium or magnesium bicarbonate.

When the hardness cannot be removed by boiling, the water is called permanently hard water.

Calcium or magnesium sulphate or calcium or magnesium chloride in water cause permanent hardness.



6.3 What chemical did water sample 2 contain?

6 Wash the test-tube, stopper, and beaker.

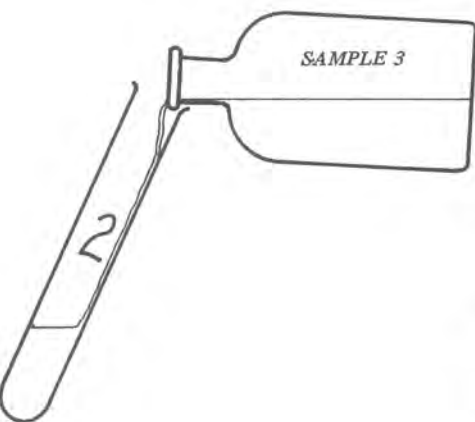
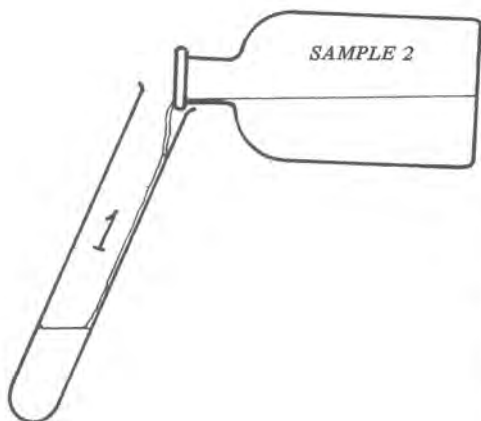
7 Pour some of hard water sample 3 into the beaker to a depth of about 2 centimetres.

8 Repeat steps 2 to 5.



6.4 What effect did boiling have on the hardness of the water. Write your answer on page 14 of your record book.

ADDING WASHING SODA TO HARD WATER



Will washing soda soften hard water? You can find out in this activity.

You will need:

- 1 marking pen
- 1 test-tube rack
- 2 test-tubes with stoppers
- 1 teaspoonful of washing soda crystals
- $\frac{1}{2}$ teaspoonful of soap flakes.

1 Wash the test-tubes and number them 1 and 2.

2 Pour 2 to 3 millilitres of sample 2 into test-tube 1.

3 Pour 2 to 3 millilitres of water sample 3 into test-tube 2.

4 Add a few of the crystals of washing soda to test-tube 1 and shake the test-tube about 20 times.

5 Add one of the soap flakes to the contents of the tube and shake it.

 6.6 What effect did washing soda have on the temporarily hard water? Write your answer on page 14 of your record book.

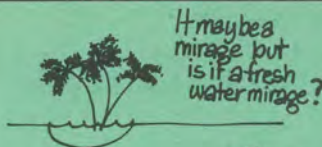
6 Add a few of the crystals to test-tube 2 and shake the tube about 20 times.

7 Add a soap flake to the contents of the test-tube and shake it.

 6.7 What effect did washing soda have on the permanently hard water?

You can check your answers on page 83 of this book.

OPTION



In this option you find out how you can increase your chance of survival if left in a desert or at sea without fresh water.

You could do this at home and report what you find out to the class. If you like write a story about survival.

Survival on Land or Water

Many people have died of thirst either in the desert or at sea. Perhaps a little knowledge would have saved some of them.



Warning: The survival methods described in this option must not be used as a substitute for carrying sufficient water. They are to be used if all other methods of obtaining water fail.

SURVIVAL IN A DESERT

When you did the activity called Does the Soil Contain Water (page 23), you saw that there was some water in the soil sample you tested.

Even in a desert some water can be recovered from the soil.

The water is being drawn up from deeper layers and evaporated by the Sun. Desert survival kits are made to trap some of this water.

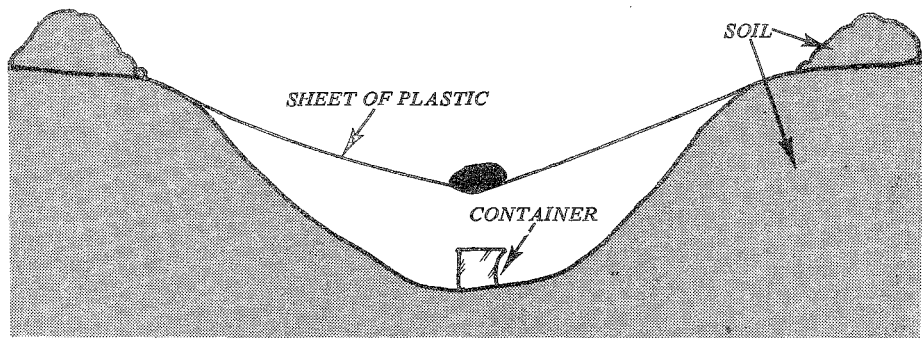


Saltbush and gibbers.

To make a survival kit you will need:

- ⊙ 1 spade
- ⊙ 1 sheet of black plastic, about 1 metre square
- ⊙ 1 container
- ⊙ 1 stone.

- 1 Dig a hole in the ground about 30 centimetres deep, and about 10 centimetres smaller in diameter than the plastic sheet.
- 2 Place the container in the centre of the hole.
- 3 Put the plastic sheet over the hole. Put soil on the edges of the sheet to prevent it from slipping into the hole.
- 4 Rest the stone in the centre of the sheet over the container.



5 Leave for a day and then remove the sheet and examine its underside, and the container.



7.1 What did you notice in the container and on the underside of the plastic sheet? Write your answer on page 15 of your record book.



7.2 On page 15 of your record book, explain why the stone was placed in the middle of the plastic sheet.

If you wanted to increase your water supply, you could add anything that might contain water—leaves, twigs, salt water, or even human excrement (urine and faeces).

Some survival kits include a plastic hose. This allows water to be sucked from the container without dismantling the kit.

SURVIVAL AT SEA

The activity *Why Is the Sea Salty?* (page 25), showed you that when water containing salt was evaporated, salt was left in the evaporating basin.

In fact, what you did was to separate the salt from the water by turning the water into water vapour.

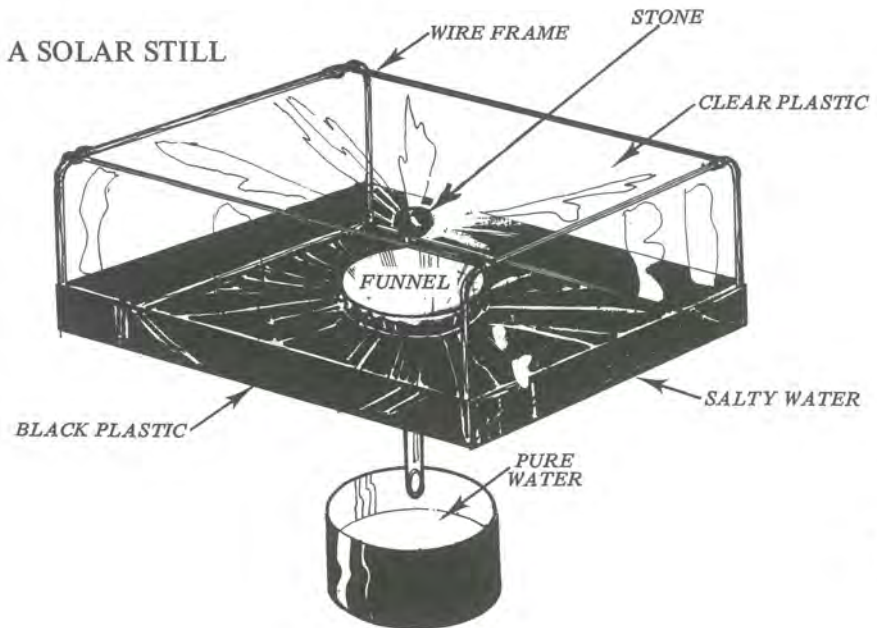
If you condensed the water vapour (changed it back to water) you would have pure water. The solar still shown in the diagram below allows you to get pure water in this way.

For best results, the still containing

salty water is placed in the sunshine. The black plastic reaches a higher temperature than the clear plastic.

Water evaporated from the black plastic container condenses on the clear plastic. The drops of water run off to the funnel. The cup below the funnel collects the drops.

You might like to make a solar still similar to the one shown in the diagram.



You can check your answers on page 83 of this book.

OPTION



this tastes
human-y



This is a reading option. You make a survey of the causes of water pollution.

Pollution in Water

Water, air and soil are **polluted** if they become unsuitable for any particular purpose. If water becomes too dirty to be used in homes or in factories, or unsuitable for watering farmlands or for swimming, the water is polluted. The material causing the pollution is called a **pollutant**.

Cities and farming areas dispose of huge quantities of waste materials. These wastes, released into the air, on to land and into waters, cause pollution. Man has always polluted the Earth, but today pollution has become a serious problem. This is due to more people producing more wastes.

WHAT CAUSES WATER POLLUTION?

Almost without exception, pollutants are waste materials that come from houses, factories and farms.

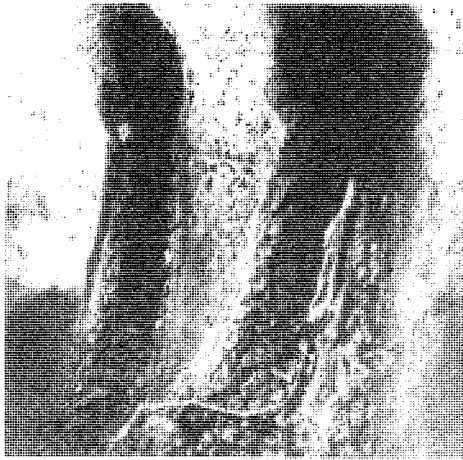
Waste materials include sewage and garbage.

Sewage

Sewage is waste material carried by underground drains called sewers. Domestic sewage contains human faeces, urine, paper, soap suds, food scraps, and other rubbish going down



Getting things out of sight does not solve the pollution problem.



This photo and the one below shows sewage being discharged directly into a river.

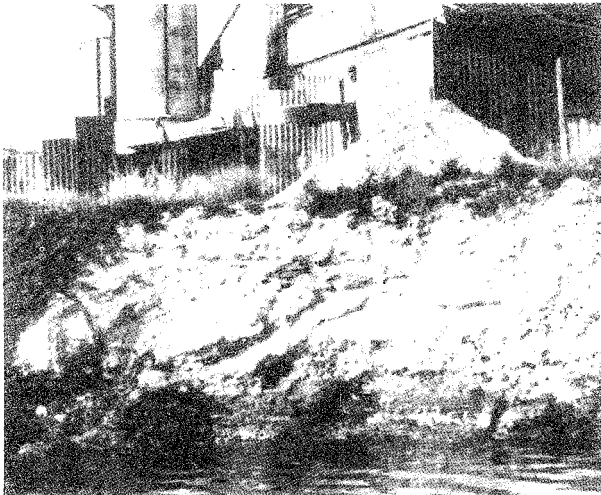
the sink or lavatory. Some sewage is treated (chemically changed) so that it does not pollute the river or sea it is emptied into. However, sometimes untreated sewage and sewage from septic tanks causes river pollution.

Factory wastes come from such places as dairy factories, meat works, fruit canneries, sugar mills, breweries, paper mills, metal industry works, agricultural and chemical plants,

petroleum and mining depots.

Some factory wastes run into sewers; some wastes are treated in the factories. Others are dumped directly into streams.

Agricultural wastes consist mainly of fertilizers, salt, pesticides, and animal manure which are washed off the surface of the land or out of the soil. After heavy rain, eroded soil itself becomes a pollutant in streams.



(Photos by courtesy of the Melbourne and Metropolitan Board of Works.)



Garbage is one cause of water pollution. (By courtesy of The Age, Melbourne.)

Garbage

Garbage is any solid waste (cans, bottles, boxes, food scraps) which is thrown out and does not pass into sewers. Domestic garbage is usually collected and dumped in special disposal areas. Unfortunately, garbage is sometimes dumped on vacant land, or in creeks. Here it also causes pollution.

EFFECTS OF WATER POLLUTION

The immediate, general effects of water pollution are that:

- Many plants and animals die. The variety and abundance of fresh-water wildlife is reduced. Valuable commercial fisheries can be destroyed.
- The water becomes unsuitable for industrial use and for recreation (swimming, fishing, boating).
- The rivers, lakes and ponds become unpleasant sights.

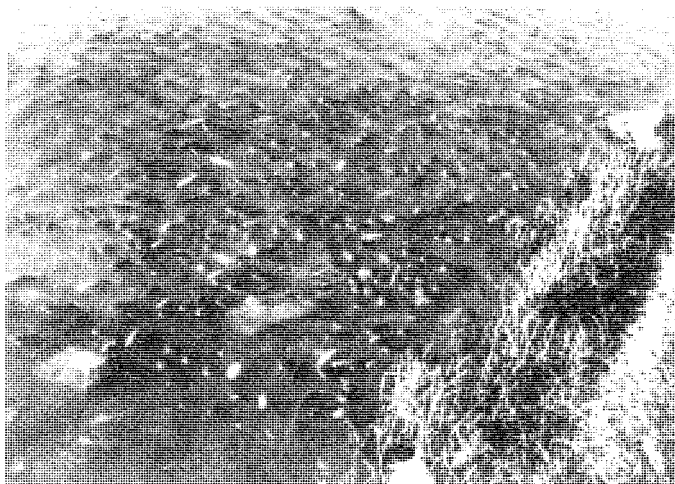
Some of the following seven things happen when water is polluted.

1 Oxygen Decreases

Food wastes, human faeces and manure provide food materials (nutrients) for microscopic animals and plants. When these nutrients are present, the animals and plants grow rapidly and increase in number. This rapid growth causes the oxygen content of the fresh water to decrease. Fish and other large animals and plants do not get enough oxygen and so they die.

Bacteria decay many pollutants. To decay wastes such as food scraps, human faeces and manure, bacteria need oxygen. The more of these pollutants there are, the more bacteria will be present and the more oxygen will be used.

Spilt oil forms an airproof layer over water. The layer prevents oxygen from the air dissolving in the water. Dissolved oxygen is necessary for the survival of fresh-water life.



Fish gasping for air in a polluted lake.

2 Sludge Forms

Solid wastes from living things can settle to the bottom of a river or lake and form sludge (thick mud). This sludge will decay and may cause the water to change in colour and become smelly.

3 Oil Slicks Form

As well as decreasing the oxygen content of fresh waters, oil slicks make

the waters unsuitable for swimming and boating. The edges of rivers or lakes or shores turn black. When birds swim in these waters, their feathers become clogged with oil. They cannot fly away and they slowly die.

Cleaning up oil slicks can cause more damage, because often detergents are used—and some of them pollute the water.



Spraying a river to clear an oil slick.

(Both photos by courtesy of The Herald and Weekly Times Ltd, Melbourne.)

4 Health Dangers Increase

Large numbers of some bacteria can become dangerous to our health. Certain bacteria in the water can cause typhoid fever, others can cause cholera and others, dysentery. Bacteria may also contaminate (infect) shellfish and oysters.

5 Fresh-water Life Is Endangered

Large amounts of many chemicals from industry are harmful to fresh-water life. The chemicals can also make the water unfit to be used by other industries.

Pesticides are chemicals which can be used to kill insect pests or weeds. Sometimes they enter fresh water:

- in industrial wastes,
- in domestic sewage,
- during insect and weed control projects, and
- when used pesticide containers are thrown into the water.

During insect and weed control work, pesticides are often sprayed from aeroplanes and some of the spray is likely to fall into the fresh waters.



Members of a pollution patrol take samples from water from the Yarra River, Melbourne. The men are standing in a drain.

(Photo by courtesy Herald and Weekly Times Ltd, Melbourne.)

Rain can wash pesticides from the land into rivers or lakes.

Small amounts of pesticides build up in the bodies of fresh-water plants and animals and cause injuries. Other animals who drink this water may be injured as well.



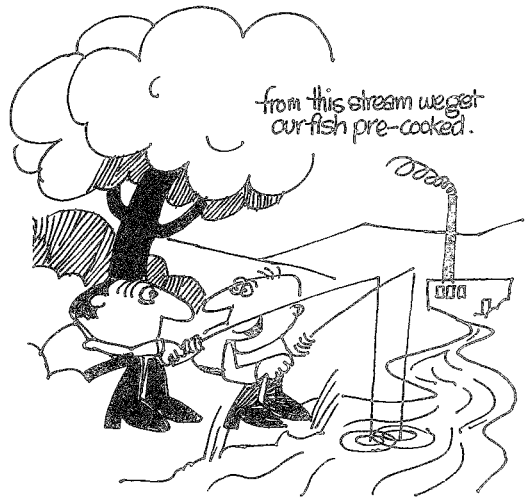
These fish died following aerial spraying of DDT—a pesticide.

(Photo by courtesy Fisheries and Wildlife Department, Victoria.)

6 Water Becomes Overheated

Many industries need water for cooling. This water absorbs heat and enters streams as heated water.

Fresh-water organisms may stand high temperatures for a few hours, but not for a period of days. Heated water also contains less dissolved oxygen than cold water, so after a few days, many organisms die.

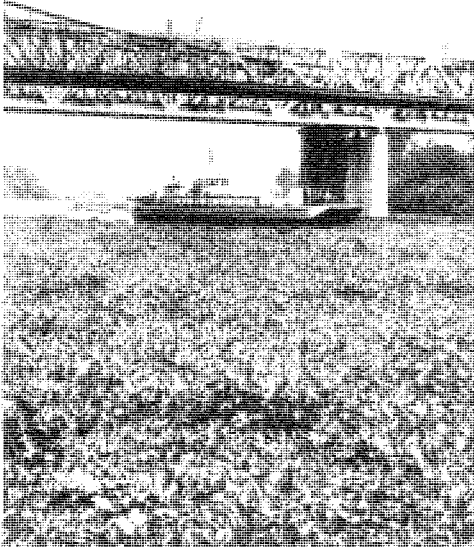


7 Algal Blooms Occur

Fresh waters contain a variety of mineral salts. These vary in amount from time to time and place to place. Certain kinds and amounts of mineral salts are necessary and bearable to animals and plants. Mineral salts, which include phosphates and nitrates, are added to fresh water through sewage, manure, fertilizers and some detergents. These salts are absorbed by algae (*al-gee*) and other fresh-water plants.

If too many of these salts enter the water, the plants grow out of control. In the case of algae, an algal bloom develops. An algal bloom is the growth of large numbers of these microscopic plants. This growth makes the water look green and become slimy.

Any type of fresh-water bloom can become a great nuisance. The plants may choke rivers or creeks and completely cover small pools or lakes. The oxygen content of the water is reduced, so the water becomes less suitable for plants and animals.



A bloom of water hyacinth covering the surface of the Brisbane River.

(Photo by courtesy The Courier-Mail, Brisbane.)

SALT POLLUTION

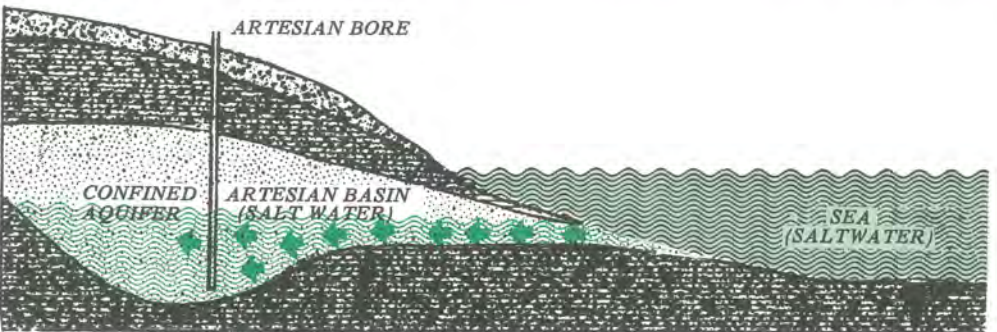
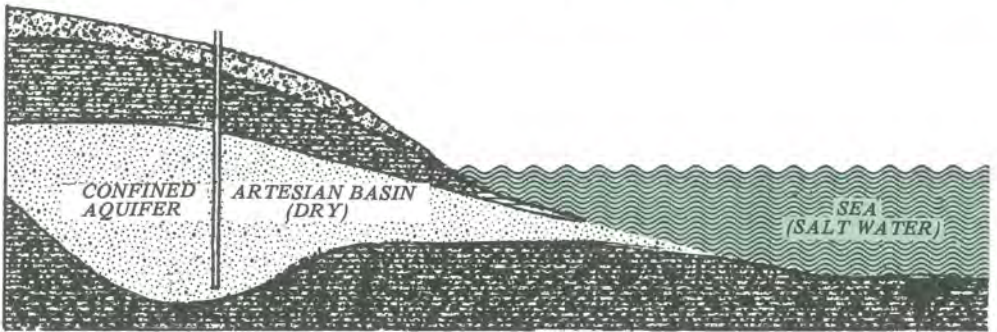
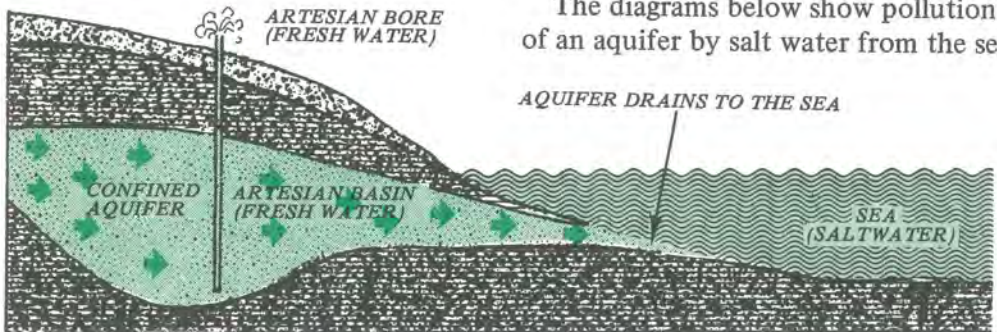
If you have difficulty in understanding this section, read Option 1 (Underground Water) before going on.

A special kind of pollution is causing trouble in two regions of Australia. Although man is responsible for this pollution, the cause is different in each case.

Salt Pollution by Sea Water

Sometimes too much water is pumped from an artesian basin which has its aquifer outlet below sea level. When this happens, water from the sea may flow back into the basin and pollute it with sea water. This has happened near the Gulf of Carpentaria in northern Australia.

The diagrams below show pollution of an aquifer by salt water from the sea.



Salt Pollution by Over Watering

There is some common salt in almost all soil, and so some dissolves in the water which seeps through the ground. In regions where the ground contains large amounts of salt, the aquifer that drains the ground carries salty water.

When crops in such areas are irrigated, water seeps through the ground to reach the plant roots.

Water not used by the plants may continue to seep through the ground to the aquifer, where it drains away.

However, if the irrigating water is added more quickly than it is used by the plants and drained by the aquifer, the water table rises.

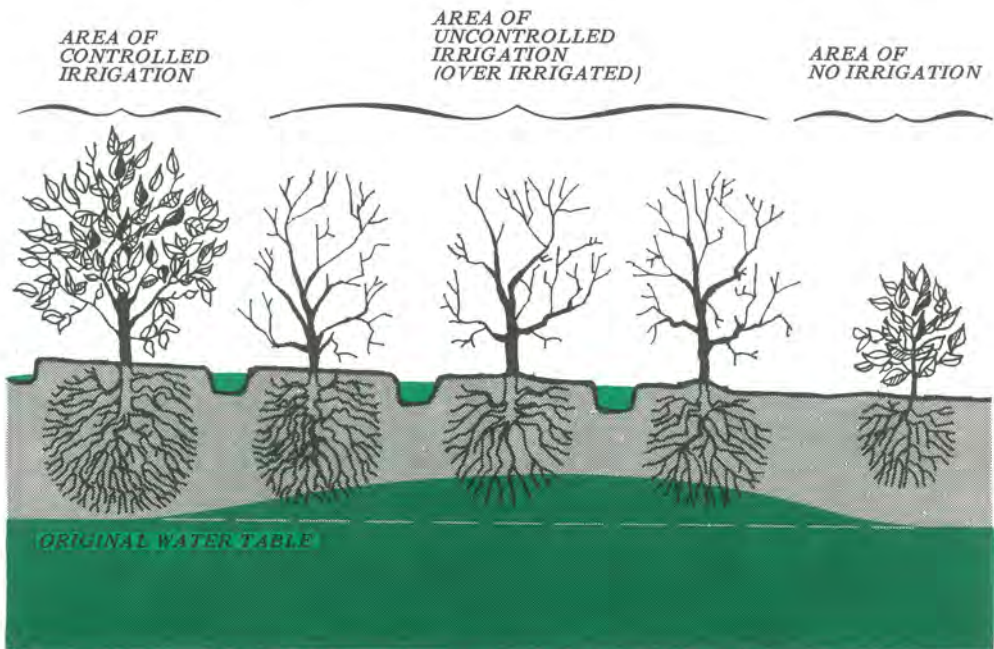
The zone of saturation below the water table will contain salty water, as

the added fresh water will have mixed with the salty water of the aquifer.

If the water table reaches the plant roots, the plants will be provided with salty water.

In the Murray River region near the border of South Australia and Victoria, irrigation water has raised the water table of salty water so close to the surface that it has reached the roots of the irrigated crops. The crops then died, because they were not suited for living in salt water.

To prevent such happenings, the amount of irrigation water to be added must be calculated and controlled.





EXTRA ACTIVITIES

You could do some, or all, of these activities. Write your answers on pages 15 to 19 of your record book.

1 What Does the Word 'Pollution' Mean To You?

After reading this option you should have some understanding of its meaning.

2 What Causes Water Pollution?

Make a list of the causes under these headings: household wastes, factory wastes, agricultural wastes.

3 What Are the Main Effects of Water Pollution?

Make a list of the effects. In each case state what causes the effect.

4 Water Pollution in Your District

Look for evidence. If you find any, tell your teacher and arrange for a class discussion. Discuss what should be done about this water pollution. How could it be reduced, or stopped?

5 The \$1000 Fine

Read the newspaper article below.

POLLUTERS FACE \$1000 FINE

The penalty for polluting Melbourne's rivers, creeks and drains has been increased steeply by \$960 to \$1000.

Polluters will also face fines of \$100 a day if the offence continues.

The new penalty, introduced by the Board of Works yesterday, will replace the old 1933 penalty of \$40, which the board chairman (Mr A.H. Croxford) described as totally inadequate.

Mr Croxford said it was "introducing a realistic penalty which will act as a deterrent to polluters of our main water courses and drains. The old penalty had as much effect as making an offender buy a beer."

The new penalties will come into effect in several weeks' time when the new by-law is gazetted.

The increase is designed to curb pollution of open canals, such as the controversial Elwood canal, and, more importantly, Port Phillip Bay.

Mr Croxford said: "The new penalties must have a beneficial effect on the Bay.

"It will reduce the amount of household garbage and other waste material poured into the drains which must in turn reduce the pollution load on all streams that eventually reach the Bay."

But he said the penalty would only be effective if the board could get the full assistance of the community.

"The community itself is the polluter, and it is the community that will have to save the environment," he said.

The penalties are designed to place effective restraints on industry also.

Mr Croxford said he hoped the penalty would encourage managers of industry to take steps to control employees who dumped chemicals and oils into drains.

"It is an impossible task for us to keep watch on all outlets 24 hours a day.

"Management is only as strong as its employees."

Mr Croxford appealed to the public to notify the Board of Works at any time of the day about any incident of pollution they saw.

"There are many thoughtless and selfish people who are using drains to the detriment of their own neighbours," he said.

● Victoria's proposed environmental authority will make uniform penalties for pollution offences throughout the State. The authority will have the power to impose fines of \$5000.

(Reprinted from The Age, Melbourne, 5 May, 1971.)

□ Do you think that this fine is too high or too low? Why?

□ What is meant by 'The community itself is the polluter, and it is the community that will have to save the environment'?

Check Your Answers

These are the most likely results. Your activities may give different results. If so, try to find out why.

SOME OF THE THINGS WATER CAN DO

1 TABLE 1

SUBSTANCE	SINKS TO BOTTOM	FLOATS ON TOP	FLOATS IN LIQUID	DISSOLVES
SAND	✓			
SODIUM NITRATE				✓
SULPHUR		✓		
COPPER SULPHATE				✓
TABLE SALT				✓
POWDERED CALCIUM CARBONATE	✓		✓	

2 The names of three soluble substances are.

- (a) Sodium nitrate
- (b) Copper sulphate
- (c) Table salt

The names of three insoluble substances are:

- (a) Sand
- (b) Sulphur
- (c) Powdered calcium carbonate

3 Powdered calcium carbonate formed a suspension.

4 The methylated spirit dissolved in water, the kerosene formed a layer on top of the water.

5 Some liquids that dissolve in water are vinegar, alcohols and detergents.
Some liquids that don't dissolve in water are kerosene, mineral oils, and mercury.

WATER FOR LIVING THINGS

6 About 67 per cent of man's weight is water.

7 About 87 grams.

WATER IS NEEDED FOR SOME CHEMICAL REACTIONS

TABLE 2

TEST-TUBE 1	CITRIC ACID	WATER	8	NO REACTION
TEST-TUBE 2		SODIUM BICARBONATE WATER	9	NO REACTION
TEST-TUBE 3	CITRIC ACID	SODIUM BICARBONATE	10	NO REACTION
TEST-TUBE 4	CITRIC ACID	SODIUM BICARBONATE WATER	11	REACTION

WATER IS A STRUCTURAL MATERIAL

- 12 The dialysis tube is swollen with water. If it is not, the knots were probably not tied tightly enough or the dialysis tube has a hole in it.
- 13 It would seem that water can pass from the beaker through the membrane of the tube into the tube. But once inside the tube, the conditions don't allow the water to pass back through the membrane into the beaker. When water passes through a membrane in this way the membrane is called a semi-permeable membrane.

WATER AND THE COOLING SYSTEM

- 14 Compare your result with that of other students.
- 15 Compare your result with that of other students.

A WATER CYCLE

- 16 Water drops form on the bottom of the flask. The cold flask caused water vapour in the air above the hot water to condense to form these drops. (Condense means 'to change from gas to liquid'.) The water vapour in the air came from the heated water in the beaker.
- 17 The water that condenses on the bottom of the flask forms drops that fall into the beaker. This completes the water cycle.

DOES THE AIR CONTAIN WATER YOU DON'T SEE?

- 18 Ice forms on the outside of the beaker.
- 19 The water producing the ice was in the air as invisible water vapour.

DOES THE SOIL CONTAIN WATER?

- 20 Drops of water form on the inside of the test-tube.

WHY IS THE SEA SALTY?

- 21 A solid remains in the evaporating basin.

Test Yourself

- 1 To determine whether a substance is soluble in water you should have made three observations:
 - ☐ Does the substance disappear?
 - ☐ Does the liquid look the same at the top and at the bottom of the container?
 - ☐ Does the substance fall to the bottom of the container after a few minutes?If you answer 'yes' to the first two of these observations and 'no' to the third then you can conclude that the substance you are testing is soluble in water.
- 2 A suspension is a mixture in which visible particles of one substance are scattered throughout the other substance. If the mixture is left to stand, the particles begin to fall to the bottom of the container. Usually a suspension is not clear.
- 3 Man loses water from his body by exhalation, sweating and urinating. This loss of water is balanced by drinking, eating and manufacture of water during respiration.
- 4 **A, B, C and D**

Water solutions in the joints help to prevent them from squeaking. The blood is the carrier of digested food and oxygen throughout the bodies of larger animals. In man, the blood is made up of about 83 per cent water. Water enters cells through semi-permeable membranes, causing the cells to swell.
- 5 **180 litres of water**
- 6 **160 litres of water**

Ken's mother used 280 litres of water during the day. Ken's brother used 120 litres of water during the day. Therefore Ken's mother used 160 litres of water more than his brother.
- 7 A semi-permeable membrane allows some substances to pass through it but not others. The 'skin' of a prune allows water to pass through it, but it does not allow the other substances it contains to pass out of it into the water.
- 8 When placed in water a prune swells because water entered the cells through the semi-permeable membranes of the cell walls. The cells became swollen with water. This process by which the cells of a prune take in water is called **osmosis**.
- 9 **C** The Sun evaporates water from the seas, lakes, rivers and the ground.

- 10 D Water vapour condenses to liquid when the moisture-laden air is carried by winds to colder regions.
- 11 A Water is precipitated from the air as rain, hail, snow or frost, depending upon the conditions of the atmosphere.
- 12 B Plants help to transfer water from the ground to the air by transpiration.
- 13 B Certain conditions are necessary for water to be precipitated. One of these conditions is that the air must be cool enough for water vapour to condense. High land causes moisture-laden winds to reach cooler regions.
- 14 D A and B. The amount of salt which comes from dead animals and plants and the ocean floor is not enough to account for the gradual increase in the saltiness of the sea.
- C The polar caps are frozen fresh water.

OPTION 1: UNDERGROUND WATER

A MODEL WELL

- 1.1 Water can be seen in the lower part of the well. The surface of the water is the surface of the water table.

WHAT HAPPENS TO UNDERGROUND WATER?

- 1.2 The height of the water level in the tubes becomes less as the distance from the aquifer inlet increases.

Explanation:

When you walk through a crowded room you find you are constantly bumping into people. They hinder your progress and use up your energy.

In the same way that people hinder your progress and use up your energy, the sand grains hinder the passage of water along the aquifer. The farther the water moves along the aquifer, the more energy is used up in overcoming the friction from the sand grains, so there is less energy available to raise the water.

WASTE DISPOSAL AND UNDERGROUND WATER

- 1.3 The starch blocked the pore spaces between the sand particles in the aquifer. This prevented water from flowing along the aquifer.

OPTION 2: WATER IN THE AIR

- 2.1 Fog occurs when air contains more water vapour than it can hold. The lifting of the fog follows warming of the air. As air warms it can hold more water vapour so becoming drier.

OPTION 3: NATURE'S THERMOSTAT

SAND AND WATER

- 3.1 The answer depends on the mass of the beaker, and how much sand you add.
- 3.2 Your answer should be the same as for 3.1.
- 3.3 When the materials were exposed to heat, the temperature of the sand rose more quickly than the temperature of the water.
- 3.4 Conclusions you might draw can be found by reading page 49 of this book.
- 3.5 Before being placed in the portable refrigerator, the liquid contained in the freezing brick has been frozen. Heat from the food in the refrigerator can then be absorbed by the brick. The temperature of the brick doesn't rise until its contents are changed back to a liquid.

OPTION 4: SOLID WATER

DIFFERENCES BETWEEN ICE AND WATER

- 4.1 Ice is solid, water is a liquid.
Ice is not as transparent as water.
Ice is usually colder than water.
- 4.2 The surface level of the ice is greater than that of the water from which it was formed.

WHICH SUBSTANCES FLOAT?

- 4.3 This answer is the weight of the cube.
- 4.4 Wood and polystyrene will float.
Brass and aluminium will sink.
- 4.5 The activity you have just done suggests that materials which float weigh less than an equal volume of water.
The materials which sink weigh **more** than an equal volume of water.

OPTION 5: PLANTS GIVE OFF WATER

- 5.1 Dry cobalt(II) chloride paper is blue.
- 5.2 Wet cobalt(II) chloride paper is pink.
- 5.3 Water collects in the plastic bag.

OPTION 6: HARD WATER

- 6.1 The order of hardness depends on the samples provided, but distilled water is not hard at all. You could compare your results with those of other students.

BOILING HARD WATER

- 6.2 Boiling removed the hardness from sample 2.
- 6.3 This sample from which the hardness had been removed by boiling contained calcium bicarbonate.
- 6.4 The hardness was not removed by boiling.
- 6.5 The sample from which the hardness had not been removed by boiling contained magnesium sulphate.

THE EFFECT OF WASHING SODA

- 6.6 Washing soda removed the hardness from temporarily hard water.
- 6.7 Washing soda removed the hardness from permanently hard water.

OPTION 7: SURVIVAL

SURVIVAL IN THE DESERT

- 7.1 If conditions were suitable, drops of water will have formed on the underside of the plastic sheet, and will have dripped into the container.
- 7.2 The stone lowered the plastic sheet above the container. This allowed the water to run down the underside of the plastic sheet and drip into the container.

Many people were involved in the development and production of ASEP units.

As well as the ideas and suggestions contributed by ASEP staff members, valuable help was given by consultants, students and teachers throughout Australia during trials.

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